THURSDAY, FEBRUARY 7, 1889.

EARTHQUAKES.

Les Tremblements de Terre. Par F. Fouqué, Membre de l'Institut (Académie des Sciences), Professeur au Collège de France. (Paris: J. B. Baillière et Fils, 1888.)

IN the introduction to his little volume on earthquakes, Prof. Fouqué observes very justly that it is only in recent years that seismology has begun to shape itself to the lines of an exact science. Its students have of late concentrated their attention on questions susceptible of direct attack by observation and experiment. The older seismologists made the mistake of attempting to take the citadel by storm, and failed. The younger school of investigators, proceeding more gradually, have at least succeeded in showing how enormously complex the problem of earthquakes in their origin and propagation really is. The older seismologists were for the most part men with little knowledge of mechanics, and their fundamental mistake was that they under-estimated the difficulty of the problem in its mechanical aspect. Setting to work with a preconceived and quite false idea of its simplicity, they used such observational data as were at their disposal to build up an elaborate structure of inference and hypothesis— a structure very ill adapted to bear the shock of the first earthquake that formed the object of scientific measurement. The foundation on which the new school builds its science is exact seismometry; and so far, little, if anything, more than the foundation is laid. It is less than ten years since instruments of precision were introduced, capable of giving complete information as to the manner of motion of the ground. We now have sufficiently full and exact knowledge of the nature of the motion which takes place at one or another point of the earth's surface in the affected region while an earthquake is going on. The elaborate recording seismographs which have been brought to something like perfection by a few enthusiastic workers in Japan have analyzed this motion as completely as can be desired. But beyond this we as yet know next to nothing with any certainty about the real character of an earthquake. The relation which exists between the motion at one point and that at another, the manner of the motion below the surface, the transformations which the seismic waves undergo *en route*, are subjects hardly touched; and no seismometric observations have as yet been made, in a single case, from which conclusions may be drawn with any certainty as to the position of the origin and the nature of the originating disturbance. These are matters which used to be glibly settled by reference to a few projected stones or cracked walls, or to the stoppage of some village clocks: if the new seismometry has not yet thrown much light on them, it has at least shown how gross was the former darkness.

It is, then, not a little surprising to find Prof. Fouqué write a book on earthquakes without so much as a chapter on seismometers. He excuses himself from taking up this branch of the subject on the curious ground that its extreme importance makes it deserve a special treatise, and further, that, as the instruments are being improved from day to day, "nous pensons que la description des séismographes et microséismographes gagnera singulièrement à n'être exposée en détail que dans quelques années." Readers of NATURE, who have had the opportunity from time to time in these pages of seeing what present-day seismographs are able to do, will scarcely agree with the author; and granting, as we very well may, that many improvements have still to be made, the results already achieved in exact seismometry are surely such as not only to justify but to demand some description of these appliances in any new treatise on earthquakes.

In fact, however, M. Fouqué has been better than his word, for, in speaking of the "intensity" and the components of earthquake motion, he has given some slight account of seismographs and seismograms. But the account is far from adequate, and is not free from serious errors. We find the old fallacy restated, that the position of the "epicentre" can be determined by observation of the azimuths of the oscillations; that the bearing of the origin is given by the direction in which pendulums are set oscillating or objects are thrown down. Anomalous cases are spoken of, but not a word is said to explain that the cases which are styled anomalous form, not the exception, but the rule, because the chief oscillations are in general not of the normal but of the transverse type. With regard to the mechanical theory of seismographs, the author is completely at sea. It is now well known that the first essential in seismometry is to secure a point of reference by having a steady mass pivoted or hung in nearly neutral equilibrium; that a stably-hung mass like a common pendulum will not do, because it acquires oscillation through the more or less close agreement between its period of free swing and the period of the successive seismic impulses. Nothing could be worse than a pendulum with the period of which these impulses happened just to agree. Nevertheless, M. Fouqué says, without hinting dissent:—

"M. Cavalleri admet, d'après ses observations, que, dans un tremblement de terre, le meilleur pendule au point de vue de l'indication des intensités est celui dont les oscillations sont synchrones avec la durée de l'ondulation du sol; les pendules à fil long donnent le tracé le plus étendu quand les mouvements du sol sont lents; l'inverse a lieu quand les vibrations sont rapides. Par conséquent, pour obtenir un tracé, qui soit l'image aussi fidèle que possible de l'intensité de la secousse, il faudrait avoir une série de pendules d'inégale longueur, et considérer exclusivement, parmi les tracés obtenus, celui qui offre les dentelures les plus allongées."

Nothing could be more complete than the misapprehension shown in this last sentence. Other indications lead one to conclude that the author's acquaintance with seismometry is not intimate, and that it has not been formed at first hand. His references to original sources of information are rare. He gives a fairly good account of the work of Milne and Gray on the measurement of the speed of propagation of artificial disturbances through the soil—a subject the author has himself investigated— but of the work of Ewing in measuring natural earthquakes, and of the continuation and extension of it by Sekiya, he is apparently ignorant. Ewing's horizontal pendulum seismograph is not described, and his duplex pendulum seismograph, although mentioned, is wrongly classed as an instrument that records the phases of the

motion in their relation to the time. The account that is given of the labours of Italian observers in the field of microseismometry is meagre and unsatisfactory, and the work of M. d'Abbadie and the Darwins in this connection is not so much as alluded to.

The only part of M. Fouqué's book which can be said to make any addition to existing knowledge is that which deals with the experiments conducted by the author and M. Michel Lévy on the speed of propagation of artificial disturbances through the earth's crust. In the first instance their method was the same as that used by Mallet and by Abbot; the seismoscope was a basin of mercury, in which the observer detected the arrival of the shock by watching in a telescope for the disturbance of the reflected light. In a second series of experiments, the personal equation of the observer was got rid of by causing a convergent pencil of light reflected from the basin to fall on a revolving photographic plate. The light was intercepted by a shutter which opened, through electric connection with a seismoscope at the origin of the shock, when the blow was given which caused the disturbance to be propagated. Then, until the arrival of the earth waves blurred the image, a sharply defined circular arc was photographed on the plate, the length of this arc serving to measure the time of transit of the waves. In other instances, where the explosion of dynamite formed the source of disturbance, the explosion was produced by an electric discharge which was made to photograph itself on the plate, thus registering the instant at which the disturbance originated more sharply than by the method of the shutter. Besides observations on the surface of the ground in various localities, and with various qualities of vibrating medium, some were made entirely underground. The author and his colleague made use for this last purpose of a mine at Commentry, by causing the explosion to take place in one gallery, 470 feet below the surface, while the seismoscope was set first on the surface of the ground and then in a second gallery 280 feet below the other. As a general result, it was noticed in all cases that the first thing to reach the seismoscope was a series of very small vibrations, which preceded the arrival of the principal shock. In surface propagation this principal shock was not unique: it was followed by several others, although the initial disturbance at the distant source had consisted in a single blow.

Notwithstanding the care and pains which have evidently been bestowed on the author's experiments, the results, as regards speed of propagation of seismic waves, seem to be subject to some uncertainty. The intervals of time actually measured were too small, and what may be called the personal equation of the apparatus was too large. The whole amount by which the record lagged through inertia of the apparatus and other causes is estimated to be 0·301 seconds. Taking one set of experiments (at Creuzot), the recorded time-interval, when the seismoscope was 490 metres from the source, was 0·105 seconds; but to this small quantity we have to add the above large error of 0·301 seconds before deducing the velocity. It should be added, however, that observations made at a more distant station gave results according well with the velocity so deduced. The velocities ranged from about 3000 metres per second in granite to 300 metres per second in sand. The results as to rocky soils are of the same order of magnitude with those of Abbot, and with the velocities which have been inferred from laboratory experiments on the density and elasticity of rocks. The figures given refer to the rate of propagation of the group of waves, as measured by the arrival of the first sensible motions—the motions, namely, which form the advancing edge of the group. But the group widens as it travels, and a much smaller speed would be deduced by reference to the passage of the principal wave or waves.

The first and main part of M. Fouqué's book, entitled "A General Study of Earthquakes," concludes with an interesting detailed account of these experiments. The second part will appeal to a wider circle of readers. It is a narrative of the principal earthquakes which have been felt from 1854 to 1887, including those of San Salvador in 1854, 1873, and 1879; of Simoda, in Japan, in 1854; of Ischia in 1883; of Andalusia in 1884; and of the Riviera in 1887. The account is pleasantly written, and is embellished by a number of photo-engravings showing the mischief wrought by these destructive shocks.

PERIPATUS.

Studies from the Morphological Laboratory in the University of Cambridge. Vol. IV.—Part 1. A Monograph of the Development of *Peripatus capensis.* Part 2. A Monograph of the Species and Distribution of the Genus *Peripatus.* By Adam Sedgwick, M.A., F.R.S. (London: 1888.)

IN these two numbers the editor has reprinted the five papers from his pen on *Peripatus*, which have appeared in the *Quarterly Journal of Microscopical Science* between 1885 and 1888. From the patient detail with which he has followed the developmental changes, and from the power of generalization from observation which he displays, this research may well be regarded as a model for those who are beginning embryological study. Memoirs such as these, on the other hand, are rarely distinguished for clearness of expression and lucid phrasing, and the one before us forms unfortunately no exception to the generality.

Since the observations of Moseley and Balfour, it has been anticipated that several difficult morphological problems presented by the Arthropoda would receive their solution from a study of the ontogeny of *Peripatus*, and in Mr. Sedgwick's hands this hope has been largely realized. The only other recent workers in this field, Miss Sheldon, Mr. Sclater, and Dr. von Kennel, have studied forms from New Zealand and the West Indies; and while the observations of the latter are in many points at variance with those before us, some of the disagreement is undoubtedly due to the different development of the different species. Like most of such primitive types, the species of *Peripatus* are widely and discontinuously scattered, and exhibit considerable structural and embryological discrepancy. Such a discrepancy occurs at the outset. The ovum of the New Zealand form is large, and consists mainly of deutoplasm; that of the Cape species, the subject of the present memoir, is smaller, and, while now actually devoid of yolk, forms a loose reticulum of protoplasm which appears to imply its former presence between the meshes: in both of these

segmentation is meroblastic. The ova of the West Indian *Peripatus*, again, are yet smaller, and totally devoid of yolk, and the segmentation is apparently complete. In other words, the reduction in size of the ovum, due to loss of yolk, which is still in process in *P. capensis*, has been achieved in the West Indian forms, and its effect shows how easily the phylogenetic significance of segmentation-types may be lessened.

We can only mention a few of the more important facts and generalizations of Mr. Sedgwick's memoir. Of great interest is the observation that the embryo, at any rate at and until the gastrula stage, is a syncytium, *i.e.* the various cells of which it is composed are only incompletely marked off from one another, being connected by radiating protoplasmic strands. Such a syncytial condition the author regards as more primitive than the complete separation of the segmentation-spheres from each other. Another point in the early ontogeny is that no part of the nucleus of the unsegmented ovum enters that central portion of the syncytium which becomes differentiated into endoderm ; and in this connection some recent observations of Hickson on segmentation in *Millepora* are of value. The ovum in *Millepora* is almost devoid of yolk, while those of the Hydrozoa generally possess a large quantity ; and we venture to think that an earlier yolked condition probably occurred in *Millepora*, though Mr. Hickson has pronounced to the contrary. The segmentation-nucleus breaks down into a number of deeply-staining fragments, which become scattered through the cell, and eventually arrange themselves as the nuclei of the blastula ; and it is at any rate possible that a similar phenomenon occurs in the formation of the endoderm of *Peripatus*, since Mr. Sedgwick describes (p. 26) " small particles of a deeply-staining matter, which are neither visible in the unsegmented ovum nor in the gastrula stages, and which are not to be distinguished from nuclear chromatin." From whatever source, amitotic nuclei presently appear in the endodermal vacuolated protoplasm, and the enteron is formed by the confluence of these vacuoles. A solid gastrula is thus produced. These facts lead Mr. Sedgwick to discuss the course of the evolution of Metazoa from Protozoa. He pronounces in favour of a " nucleated Infusorian-like animal, with possibly a mouth leading into a central vacuolated mass of protoplasm," for the transition-type, as against a colonial Protozoan ; and declines to accept Metschnikoff's hollow blastula as an even more primitive form than the solid gastrula.

The nephridia, the existence of which is one of the most remarkable features of *Peripatus*, present two special modifications, those of the third somite becoming the salivary glands of the adult, and those of the twenty-first functioning as generative ducts. The generative glands themselves are formed as two continuous tubes from the dorsal sections of somites 16-20 by a separation from the ventral sections and absorption of the septa. With reference to the cœlom, Mr. Sedgwick comes to several important conclusions. The mesoblastic bands appear as a proliferation of nuclei at the lips of the blastopore, which arrange themselves in groups round a succession of cavities to form the future somites ; a mode of connection generally taken to imply an obscured enterocœle. This primary enterocœlic system

of cavities is represented in the adult merely by the generative glands and the nephridia ; the latter are, as the author insists, not connected with, but actual parts of, the cœlom, and open each into a hitherto undescribed vesicle in the leg, which at no period communicates with the perivisceral space. Heart, pericardium, and perivisceral cavity are the outcome of spaces *secondarily* excavated in the mesoderm in connection with a vascular system, and are best designated by Lankester's term hæmocœle. Such a hæmocœle is characteristic of Mollusca and Arthropoda, and Mr. Sedgwick's deductions tend to show that in the latter group also the generative glands and ducts and the excretory antennary glands are the sole remnants of the true cœlom.

In the second part, which deals with the genus from a systematic stand-point, Mr. Sedgwick criticizes the various forms hitherto described. He recognizes nine good species, of which two are new : four from South Africa, two from the Australian region, and three from the Neotropical. The coloured plates which illustrate this section are most creditable to the lithographers of the Cambridge Scientific Instrument Company. In future volumes of the " Studies " an *exact* reference to the place where the original paper is to be found would often spare trouble to the student of zoological literature.

THE TEACHING OF CHEMISTRY.

The Fundamental Principles of Chemistry practically taught by a New Method. By Robert Galloway, M.R.I.A., F.C.S. (London : Longmans, Green, and Co., 1888.)

THE first thing that strikes one in taking up this volume is that it requires cutting. This is a considerable drawback to the student working from it, especially in those cases where the description of an experiment is continued on the next page, and to the mere reader it involves a trouble that ought not to be imposed upon him. But a far more serious fault is the absence of even an attempt at an index. Whether the author, the publisher, or the binder is to blame for this omission is not obvious, but the fact remains that the book is incomplete.

The difficulty as to where the beginner shall begin must have presented itself in some form or other to every earnest teacher. Shall the facts come first in their then necessarily isolated condition ? or shall the student begin with theories, making for himself so many mental pigeon-holes into which the facts as they come may be put away in an orderly manner ?

The majority of teachers at the present day prefer to have something to classify before they attempt a classification with their pupils, and in so doing we think they adopt a perfectly sound and natural method. The earnest student is anxious to get on from the very first day of his course, he craves to get hold of something tangible ; and the teacher who treats him like an empty reservoir, that is to be elaborately prepared and carefully tested as to perfection of soundness before any water is admitted to it, will ignominiously fail.

Probably every teacher of chemistry has found difficulty

in getting his students to understand in a satisfactory way the effects of changes of temperature and pressure upon gases individually and in general, after the student has performed the ordinary elementary experiments upon the principal gases. But turning to this subject in the present hand-book, we find that the student has to study these effects before he has seen or read of any gas whatever, unless we suppose that "the gas" at gas-works, or the air mentioned in earlier chapters, will be retained in the student's mind and applied by him to the rules given. In the questions set on this part of the subject, "a gas" is the vague expression almost always used, for fear, we presume, it should be imagined that the rules given are more intimately connected with oxygen than with hydrogen, &c.

In the early pages the learner is introduced to gases by the statement that gas-holders are "employed at gas-works for holding the gas," and is then instructed, without even the suggestion of an experiment, how to collect gases over water and in other ways, how to transfer gases to the lecture table, how to burn substances in gases, to burn gases themselves, to generate gases when heat is required and when heat is not required, and so on. The student, having got this abstract information in all its minuteness of practical detail, is expected to keep it in his memory, and to work and study through nearly two hundred pages dealing fully with, to him, a vast variety of complex subjects, before he can apply it to practical use in relation to hydrogen. By dint of much searching (for there is no index, and hydrogen does not appear to be mentioned at all in the meagre contents table) we have found a paragraph headed "Hydrogen" at p. 213. In this page no experiments are set down to be done, and the first suggestion of any practical exercise is the statement that "it can be obtained, as has been shown (Experiment 400), by electrolyzing water." The past and future are here confused, for Experiment 400 is twenty-two pages further on. This is apparently an unintentional memory exercise for the student. A few lines below, it is stated that "it is usually obtained by the action of H_2SO_4 or HCl on Zn or on Fe (see note, p. 183)." At this page we find a jar of hydrogen is required for an experiment (to extinguish burning phosphorus with), and in a note a method by which hydrogen "may be prepared" is given, with far too little description for a beginner and far too much for anyone else. We venture to predict that before many students have worked through this volume, one will be found to march off with a jar to the "gas-works" to get it filled with hydrogen, with the full conviction that he is carrying out, if not the specific instructions before him, at least an alternative way set down in the book to get his hydrogen to extinguish his phosphorus with.

There is a large measure of truth in the old saying that "example is better than precept," and this when translated into chemical language tells us that "experiment is better than theory." Theories in chemistry are of no use whatever to the student except as they enable him to remember, classify, and utilize his facts ; and if the theories are to be divorced from the facts, or if the facts are only to be introduced as if they were accidental illustrations of the theories, then the study of—so-called—chemistry becomes as useless as the study of the

dead languages. We consider that any method of teaching that tends to lead the student of chemistry to regard the theories he has to learn as anything more than suggestions that will be of assistance to him, is calculated to injure whatever of scientific capability he may possess. Good and useful theories have been believed in, and they have had to be modified, enlarged, or rejected as the growing richness of facts has demanded more extensive ideas. To teach the theories without the facts is to teach the fallible side of the science, and to make the theories more important than the facts is to attempt to balance a pyramid upon its apex.

OUR BOOK SHELF.

Treatise on Meteorological Apparatus and Methods. By Cleveland Abbe, A.M. (Washington : Government Printing Office, 1888.)

METEOROLOGICAL observations have been made more or less continuously since the days of Ferdinand II., Grand Duke of Tuscany, who first organized systematic observations in the year 1653. A full account of the progress which has been made since then in securing data of greater accuracy is contained in the book before us, which forms the forty-sixth appendix to the Report of the Chief Signal Officer to the United States Government. There are five different sections, one being devoted to temperature, one to pressure, one to atmospheric movements, one to aqueous vapour, and the last to the measurement of rain and snow. Each section commences with a general statement of the object to be attained, then the formulæ for correction are discussed, and finally there are descriptions of the most accurate instruments which are at present available. Every form of meteorological instrument hitherto conceived seems to find a place in this wonderfully complete treatise. Besides the ordinary instruments, all the self-recording arrangements are described, and their relative merits discussed. Diagrams of most of the instruments are also given. Those who have but a slight acquaintance with the subject will no doubt be surprised at the number of different methods of determining the same data, and at the number of corrections which it is necessary to make before the results can lay claim to scientific accuracy. The methods and standards adopted by the International Bureau of Weights and Measures are fully considered in every case where they are applicable.

The treatise will be invaluable to all meteorologists, and will undoubtedly do a good deal towards extending the usefulness of meteorological observations generally. Other treatises on optics, electricity, and actinometry are to follow.

New Zealand of To-day. By John Bradshaw. (London : Sampson Low, 1888.)
Round about New Zealand. By E. W. Payton. (London : Chapman and Hall, 1888.)

IN each of these books there is a full and interesting account of the present condition of New Zealand. Mr. Bradshaw's indignation has been excited by some of the hasty judgments expressed by Mr. Froude in "Oceana," and "New Zealand of To-day" may be regarded as to some extent an answer to Mr. Froude's criticisms. Mr. Payton's book consists of "notes from a journal of three years' wanderings in the Antipodes," and the impression produced by his narrative is not essentially different from that of Mr. Bradshaw's more polemical work. Both writers believe strongly in the future of New Zealand, and express warm admiration for the great results already achieved by the colonists. Yet it cannot be said that

either writes extravagantly, or that, in describing the social, industrial, and other characteristics of the colony, they have allowed themselves to be unduly swayed by mere feeling. They have, of course, a good deal to say about the Maoris, and it is worth noting that each refers to habits and physical conditions which cannot but tend to hasten the decay of that interesting race. A strong liking for whisky is unfortunately characteristic of most Maoris, and Mr. Payton remarked that the state of drunkenness appeared to have a great fascination for them. " I once saw a Maori that I knew," he says, "walking up and down the veranda of an hotel, and looking very much disgusted about something. On my asking him what was the matter, he told me he had had thirteen glasses of whisky, and *couldn't* get drunk ! "

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Solar Halo.

BETWEEN 1 and 2 p.m. of January 11, a solar halo, so remarkable as to deserve some notice in the columns of NATURE, was observed and sketched by myself and several of my pupils. The mock suns A, B, and D (see diagram below), appeared to be at the usual distance of about $22\frac{1}{2}°$ from S, and the halo at E about the same distance from D.

A and B were quite bright, but D and E were nearly twice as brilliant, and blazed with gorgeous prismatic colours.

The parhelic circle—observed by Prof. William Ellis on April 1, 1886 (NATURE, vol. xxxiii. p. 535)—was very bright. It extended only from the mock suns A and B outwards from S to about 120° from the latter ; and on the right branch of this circle was another mock sun (not shown in diagram) at the dis-

tance of about 90° from B. This last sun, as well as the visible portions of the parhelic circle, was formed of pure white light, and the latter was everywhere parallel with the horizon.
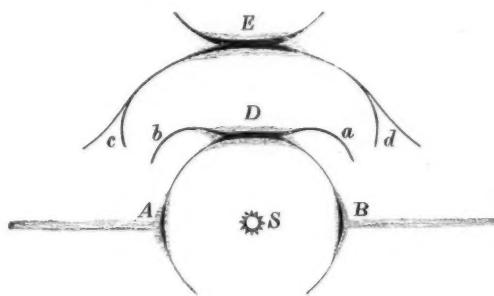
But perhaps the most remarkable part of the phenomenon was the forking of the arc *c* E *d* at the ends *c* and *d*, and the concave recurving of the arc *a* D *b* (convex to S at D) at the ends *a* and *b*. These forkings and recurvings were very distinctly visible at about 1.30 p.m., traced in fainter prismatic hues.

There was a light cloudy haze covering the southern two-thirds of the sky, while the remainder was clear. Calm moderate weather both preceded and followed the phenomenon for some days.   EVAN MCLENNAN.

Brooklyn, Iowa, U.S.A., January 14.

[The altitude of the sun is not given, but (according to Bravais) it must have been less than 30°, because of the extreme vividness of the tangent arc to the halo of 46°. This also accounts for the "recurved" appearance of the tangent arc to. the halo of 22°. The apparent bifurcation of the halo of 46° is too rudely drawn to afford the means for a rigorous investigation. As sketched, it may be due solely to diversity of inclination (*balancement*) of the axes of the ice-crystals.—ED.]

Seismic Disturbance at Venezuela.

ABOUT the middle of November 1888, there was a notable seismic disturbance in several places of Northern Venezuela. On the 13th, at 4h. 30m. a.m., a rather heavy concussion was felt at Caracas, and eastward as far as Rio Chico, where it caused some damage. On the 17th, two shocks were noticed at Cumaná, viz. at 5h. 8m. a.m. and 2h. p.m. It is reported that their force diminished towards the east, so that they were scarcely perceptible at Carúpano. On the same day two shocks (1h. 45m. and 5h. 15m. p.m.) damaged in a somewhat serious manner a large number of houses at Guanare (69° 20' W. of Greenwich, 8° 45' N. lat.) ; two more were felt at the same place on the 18th at 3h. p.m., and on the 19th at 1h. 10m. a.m. The ultimate sign of the paroxysm was observed at Caracas on the last-named day, a few minutes before five o'clock in the afternoon. The zone of disturbance extended from Carúpano to Escuque (63° to 70° W. of Greenwich), and embraced the whole mountainous part of Northern Venezuela. In some cases the wave-motion is said to have been plainly north-east to south-west ; but the maximum of disturbance (first shock at Guanare) showed decidedly a direction from north to south, as results from the numerous cracks in damaged walls and the way in which free-standing objects were thrown off their bases. The clock at the telegraph station, which hangs on a wall running east to west, was likewise instantly stopped. Dr. Lisandro Alvarado, a physician who resided at Guanare, who communicated these facts to me, informs me at the same time that the cracks emerge in an angle of from 75° to 80°. It is therefore very likely that the centre of the shock was not far from Guanare towards the north, where the crystalline schists of the Cordillera break through the overlying clay-slates and Cretaceous rocks, which form the northern margin of the great plains or *llanos* of Venezuela. Guanare lies on the very edge of these plains (185 metres above the sea), where the Cretaceous formation rather abruptly is met by the extensive deposit of conglomerate which covers the plains. Any disturbance in the raised strata forming the southern slope of the Cordillera will thus manifest itself with particular intensity in the vicinity of this border-line. The whole disturbance belongs, of course, to the class of tectonic earthquakes, as, indeed, do all those which happen now and then in this country.   A. ERNST.

Caracas, January 6.

Opportunity for a Naturalist.

CAPTAIN JUAN PAGE, of the Argentine Navy, who is now in London, and read a paper on the exploration of the Rio Vermejo and Rio Pilcomayo at the last meeting of the Royal Geographical Society, has undertaken a new expedition for the survey of the Pilcomayo from the Paraná to the frontiers of Bolivia. Captain Page would be glad to give a place on the staff of this Expedition to a naturalist, who would thus have an opportunity of investigating the almost unknown fauna and flora of the Gran Chaco, through which the Pilcomayo runs. The Expedition will start from Buenos Ayres in June next, and be absent about six months. The naturalist would have to find his passage out to Buenos Ayres, and home, and his own equipment and collecting-materials, but on joining the Expedition would be free from charges. I should be glad to put any qualified person who might wish to avail himself of this excellent opportunity of exploring a most interesting country in communication with Captain Page.   P. L. SCLATER.

Zoological Society of London, 3 Hanover Square,
London, W., February 4.

Mass and Inertia.

DR. LODGE (NATURE, January 17, p. 270) seems to have misunderstood the bearing of my letter on mass and inertia (January 10, p. 248).

I was careful to point out that my remarks on the advantages of a *force*-time-length system of units had reference solely to *procedure in teaching*. Dr. Lodge, failing to observe this, objects to the suggestion because it does not immediately afford an absolutely permanent, universal unit of force. It was not intended to do so. Anyone who has learnt dynamics and attained clear ideas, appreciates the convenience of the *inertia*-time-length system for the purposes of the record. But the teacher's business is with those who have not yet learnt, but who, knowing nothing

yet of inertia, are—in this country, at any rate—already accustomed to pounds or ounces as the practical units of force. My suggestion is simply, " Don't swap horses while you are crossing the stream."

Dr. Lodge appears to object to my using the word inertia in the sense of the coefficient m. But he does exactly the same in his own book on "Mechanics" (p. 49) ; and the usage is, I think, quite common.

A. M. WORTHINGTON.

R.N.E. College, Devonport, January 26.

As a student and teacher of physics who has come much into contact with engineers and other artisans, I venture to say a few words on the vexed question of dynamical units now under discussion in your pages. It seems to me that it would be a distinctly retrograde step to adopt the proposals which Mr. Worthington makes in a recent number of NATURE. It would amount virtually to a return to the cumbrous and discredited system of units in use in British text-books of dynamics before the appearance of " Thomson and Tait," and the introduction of the Gaussian units of mass, force, &c.

It is certain that, whether the word "pound" be properly used to denote a unit of force or not, a common usage of the term is to denote a certain quantity of matter—that which has the same gravity at the same place as the so-called standard of weight. This is a standard quantity of matter and is a constant. Now in dynamics the primary property of matter is inertia, and inertia alone. When we compare the masses of bodies dynamically, we compare only their inertias ; and that the forces of gravity on different bodies are proportional to their masses we have from Newton's pendulum experiment, &c. It seems natural and convenient, therefore, starting from this primary property of matter, to take the unit of mass as we find it defined, and give to that unit the unit of inertia. Then if the numeric of mass of a particle be m, of its acceleration dv/dt, the numeric of the inertia-reaction is $m . dv/dt$ simply. The plan proposed by Mr. Worthington would introduce quite gratuitously the relation of his "unit of inertia" to the unit of mass, a relation which has been in the past—and would, I fear, be again—a great source of confusion to the student.

It is to be remembered, further, that the Gaussian system of units has been adopted by most civilized nations for practical electrical work. Certain units are constantly used in electrical engineering, which are simple multiples or submultiples of the various derived units in this system. It is too late in the day to change all this, and thereby run the risk of throwing things into the state of chaos from which with great labour and trouble they have been rescued. Hence the engineer, whatever units he uses for steam-pressures, &c., must, if he is taught dynamics at all, be taught how to express results given in gravitational units in terms of units independent of locality, or any other varying circumstance. It seems to me desirable, therefore, on the ground that the Gaussian system of units is in use in a great and growing department of engineering, to adopt it in our teaching at the outset. The true relations of other units is then got at once, and unfailingly.

My experience as a student and as a teacher is all in favour of the system and nomenclature followed by the persons whom Prof. Greenhill (I think) called "precisionists." Words are, of course, used in more senses than one in popular language ; but if a popular word, such as "pound" or "weight," is to be adopted for scientific use, a restriction of its meaning to one sense is absolutely necessary if confusion is not to result. This, at any rate, is the principle on which scientific nomenclature has proceeded hitherto. This precision in the use of terms is absolutely necessary in teaching, and confusion of thought cannot be avoided without it. Of course there is want of consistency—no teacher can be perfectly precise ; but that is hardly an argument for throwing precision overboard altogether.

Methods of teaching, after all, must stand or fall by their results, and I should like to join my testimony to that of those who say from experience that the Newtonian method in its original simplicity, with the system of units which Gauss gave, and which has produced so great and far-reaching scientific results, is the best way of approaching the study of dynamics. Students properly taught in this way have no difficulties beyond those inherent in a confessedly difficult subject.

ANDREW GRAY.

University College, Bangor, January 28.

Use of Sucker-Fishes in Fishing.

WITH reference to Mr. Sclater's note in NATURE of January 24 (p. 295), on the use of the *Remora* in fishing, I would like to call attention to the use of sucker-fishes by the aboriginal inhabitants of Cuba. Ferdinand Columbus ("Churchill's Voyages," 1704, vol. ii. p. 616) says these people used the sucker-fish to catch both other fish and turtles. These fishes when tied " by the tail run themselves against other fish, and by a certain roughness from the head to the middle of the back, they stick so fast to the next fish they meet, that, when the Indians perceive it, drawing their line, they draw them both together."

Lightcliffe, Yorkshire, January 26.   H. LING ROTH.

Remarkable Rime and Mist.

THE extraordinary rime described by your correspondents was also experienced here (at 425 feet above sea-level) in January. Though not an unusual occurrence in severe weather, this has never been equalled in my recollection.

The freezing fog lasted three days, each succeeding one appearing to add to the thickness of the rime, which culminated on the 6th, when it was difficult to believe that the trees were not covered with snow. On that date I measured one of the sheaves of spiculæ attached to a terminal shoot of a beech-tree, and found it very nearly $2\frac{1}{2}$ inches in length. This, of course, was rather exceptional.   E. BROWN.

Further Barton, Cirencester, February 1.

IT seemed to me scarcely necessary to mention the amount of what may be called, for the sake of brevity, "sooty matter," in the rime referred to by Mr. Maw (p. 295). Some of the products of combustion are frequently restored to the ground without contact with water particles ; but many are carried about in the atmosphere for a considerable time, and are returned to the earth through aqueous precipitation. I am not sure that the subject of the varying results of analyses of rain-water, obtained under various conditions of weather, has received the amount of attention which it deserves. The heavy rains of our summer thunderstorms seem to contain less sooty matter than is brought down in drizzling rain, when we have made the necessary allowances for direction and force of wind, hygrometrical and thermal conditions, type and quantity of previous rainfall, &c. This is probably due to the fact that rain-drops of the thunderstorm fall from the greater altitude and fall more vertically through the lower strata of the atmosphere. I should, however, like to learn from some readers of NATURE whether the larger rain drops may not also, from the motion of air which they produce, treat some of the particles of sooty matter with the kindly neglect shown by them to the midges. Snow (as, I suppose, most people have observed by the sense of taste, without chemical analysis) contains, when melted, more sooty matter than rain, and I should have expected the inhabitants (including, of course, the tobacconists) of certain localities on our globe to feel rational gratitude to those slanting flakes which, in their voyage through our air, cleanse it of its sooty particles at those seasons when we are most fertile in producing the latter. But the drifting fogs which traverse a considerable area of land where there are factories, chimneys, &c. (their water-particles moving in lines nearly concentric with the earth's surface, and at no great height above it), should give the air a more thorough washing than is provided by the more common forms of precipitation. The ice-crystals produced by such fogs necessarily furnish, when melted, a maximum of sooty matter.

The letter from Mr. Lowe (p. 319) confirms what was anticipated, that the fog and rime were considerably less in the west of England than in the Midlands. It is perhaps contrary to the rules of good taste for me to criticize the words of so great an observer as Mr. Lowe, but is it not a contradiction of the laws which govern atmospheric phenomena, considering the great distance between true cirri and the fog described, to suppose that the upper surface of the latter " rapidly changed to cirri clouds " ?

Speaking of mist, it is almost impossible not to refer to the very interesting article by Prof. J. H. Poynting, F.R.S. (p. 323). May it not be possible that the quivering so often seen in a summer haze is, after all, the result of evaporation, as Wordsworth, the poet of Nature, himself seems to have thought in his use of the word "steam," in " The Excursion."

ANNIE LEY.

PENETRATION OF DAYLIGHT INTO THE WATERS OF THE GENEVAN LAKE AND INTO THE MEDITERRANEAN.

A SPECIAL COMMISSION appointed by the Society of Physics and Natural History to study the colour and transparency of the waters of the Lake of Geneva have investigated the extreme limit reached by daylight in the depths of the lake.

Many naturalists have investigated this interesting subject. Amongst others, Prof. F. A. Forel, of Morges, spent much time in investigating the Lake of Geneva. Using paper specially prepared for photography, M. Forel arrived at very interesting conclusions as to the greater transparency of the water in winter than in summer. But the paper was not sufficiently sensitive to permit of the determination of the exact limit to which the light of day extends in the depths of the lake.

Another Swiss naturalist, M. Asper, engaged in the same research, and examined several lakes, especially Zürich and Wallenstadt, for the extreme limit of the penetration of daylight. He made use of dried photographic plates of gelatine-bromide of silver. Proceeding in the same way as M. Forel, he put his plates in in the night, and took them out the following night, thus neglecting the action exercised on the sensitive plate by the light which still exists in the sky, even on a moonless night, at the moment of putting in and taking out.

This action, however, should not be neglected, and its neglect is the source of considerable error. The researches of M. Asper were carried out in lakes where the waters are less pure, and therefore less transparent, than those of the Genevan lake ; they are therefore special to the lakes which he studied, and do not bear upon our lake. M. Asper, having found light at the lowest depth to which he immersed his plates (140 metres), could not answer the question as to the limit of penetration.

1. On the Extreme Limit of the Penetration of Daylight into the Waters of the Lake of Geneva.

The recent work, like that of M. Asper, consisted in exposing photographic plates at various depths in the deepest parts of the lake. The rapid gelatine-bromide plates of Munkhoven were used. A special apparatus, warding off from the sensitive plate all light other than that which really penetrated at the depth to which it was plunged under the water, was added. This apparatus, constructed by the Genevan Society for the Construction of Instruments in Physics, consists of a box of rectangular shape, of brass, 40 centimetres in length and 20 in breadth, containing in the middle a sensitive plate fixed by wedges. This frame is closed in the upper part by two brass shutters, gliding into grooves with double borders, separated from each other by means of a strong spring contained in the bottom of the box, so as to leave the plate entirely uncovered. At the bottom of the frame a strong shaft is fixed in the form of a $\perp$, which bears the axes of rotation of two levers coupled in the form of scissors. Each of the levers ends in the upper part in a fork whose teeth pass from one side of the frame to the other, and lean against two branches which each of the shutters bears. Under the action of the inner spring the shutters separate, and with them the two arms of the lever. A weight is suspended at the opposite extremities of the two levers, and acts on them like the pressure of the fingers closing a pair of scissors ; the two forks approach one another, and with them the two shutters, which then cover the plate entirely and defend it from any luminous action from without. A hook fixed to one of the shutters, turns on the apparatus when it is shut, and hangs in the groove of the other shutter, preventing them thus from separating during the transport from the dark chamber to the site of the experiment ; it is raised only at the moment that the apparatus is attached to the sounding-line and worked on by the weight ; as soon as the sounding-weight reaches the bottom, it opens under the action of the antagonistic spring ; it closes again immediately it is withdrawn, and the weight leaving the bottom recommences to act. The depth having been ascertained by previous sounding, the length of the cord is regulated by which the weight is suspended to the apparatus, 100, 200, 300 metres for instance, at the distance desired from the surface of the water. After exposure for a certain time, the apparatus is withdrawn and carried into the dark room established on the ship in order to change the plates, and, if necessary, to develop them immediately.

The duration of the exposure has been about ten minutes. The development has been effected by means of oxalate of iron, with which the workers acted on each plate for ten minutes. The plates were all covered by the same emulsion.

Experiments have been made near Evian, where the lake presents a pretty wide plain at 310 metres depth. M. Marcet was twice kind enough to put his steam yacht, the *Heron*, at the disposal of the Commission ; and Prof. Forel, of Morges, was kind enough, not only to lend his sounding-line, but to aid by his advice and his experience.

August 16, 1884, weather clear, sun bright : (*a*) at 237 metres, two plates, one at 12.30, the other at 1.7 ; (*b*) at 113 metres, a plate at 2.30 ; (*c*) at 300 metres a plate at 2.44.

September 23, 1884, dull, but very clear weather, thin, pretty luminous clouds, light wind varying from east to north, we exposed : (*d*) at 147 metres, a plate at 1 o'clock in the afternoon ; (*e*) at 170 metres, a plate at 2.26 ; (*f*) at 113 metres, a plate at 3.3 ; (*g*) at 90·50 metres, a plate at 3.34.

For the sake of comparison, M. Fol had, on August 15, at 10 p.m., exposed on a clear but moonless night : (*h*) a plate in the open air for ten minutes ; (*i*) a plate in the open air for five minutes.

It was found that plate *c* (300 metres in depth) had received no luminous impression whatever. It was the same with plate *a* (237 metres). Plate *e*, at 170 metres, was lightly veiled, almost like plate *i*, exposed for five minutes during the night. Plate *d*, at 147 metres, had been vividly impressed, more than plate *h*, exposed in the night for ten minutes. Of the two plates at 113 metres, the plate *f* of the second day is much darkened, whilst plate *b* of the first day is no more impressed than plate *d* of the second day. Plate *g*, exposed at 90 metres, is so impressed that characters which had been traced on the back are only incompletely reserved on the dark background of the developed layer.

On comparing the results obtained in the two days of experiment one is struck by the fact that the photographic effect was much stronger on September 28 than on August 16.

From these two attempts the conclusions are drawn :—

(1) That daylight penetrates into the waters of the Lake of Geneva in September at 170 metres depth, and probably a little beyond that ; that at this depth the amount of light in the day is almost similar to that perceived in a clear moonless night.

(2) That at 120 metres the action of transmitted light is still very strong.

(3) That in September, in dull weather, light penetrates in greater abundance and more deeply into the water than in August in fine weather.

Later experiments will show us whether this difference is to be attributed to the greater transparency of water in autumn and winter, which the experiments of M. Forel ascertained beyond doubt, or if the light diffused by the clouds penetrates more deeply than the more or less oblique rays of the sun.

Before these experiments M. Asper had exposed plates of gelatine-bromide in the Lake of Zürich at depths be-

tween 40 and 90 metres, in the Lake of Wallenstadt from 90 to 140, and he obtained an effect from all. He put them in in the night, left them exposed a whole day, and took them out the following night. But, as the exposures of plates *h* and *i* have shown, the darkest night is still light for a plate of rapid gelatine-bromide.

2. *On the Extreme Limit of the Penetration of Daylight into the Waters of the Mediterranean Sea.*

After being assured by the experiments in the Genevan lake that their apparatus worked well, the Commission desired to make similar experiments in the sea, in which the greater transparency of the water would lead one to suppose that the extreme limit of the luminous rays would be at a still lower level.

No satisfactory experiments had yet been made in regard to this, for the experiments of the *Porcupine* were not carried out, M. Siemens's apparatus refusing to work.

Owing to the kindly mediation of Dr. J. Barrois, Director of the Zoological Station of Villefranche-sur-Mer, the *Albatros* was put at the disposal of the Commission for several days in the spring of 1885.

The method of procedure was the same as for the experiments in the lake, only that it was important to preserve the sensitive plate against the chemical action of the salt water by adding a thick layer of varnish to the bitumen. The luminous impression was made by the back of the plate and through the thickness of the glass. Repeated washings with essence of turpentine and alcohol sufficed to remove the varnish before proceeding to the development. As before, oxalate of iron was used.

The experiments took place on March 25 and 26, 1885, and were favoured by calm and fine weather. The depths wanted were found near Cape Ferrat, from 400 to 600 metres.

A. From 10.30 to 10.40, plate exposed at the depth of 200 metres to start with.

B. From 12.45 to 12.50, at a depth of 280 metres.

C. From 11.30 to 11.40, at a depth of 345 to 350 metres.

D. From 10.55 to 11.5, at a depth of 360 metres.

E. From 10.15 to 10.25, at a depth of 380 metres. This experiment took place under exceptionally favourable circumstances; there was no breeze, the ship remained perfectly stationary, and the line perfectly vertical.

F. From 1.20 to 1.30, cloudy but pretty light, at a depth of 405 to 420 metres. All these plates except F were exposed during bright sunshine.

Plates A and B were found to be very much impressed. On the plates C, D, and E the strength of the impression diminishes very regularly with the increase of depth. On plate E the strength of the impression is notably inferior to that of an exposure of the same duration in the air, on a clear moonless night. It may be compared to that of a shorter exposure, five minutes only, in the latter conditions. Plate F does not bear the least trace of any impression whatever. It is no doubt to be regretted that this last experiment did not take place, like the others, in clear weather. But the degree of the impression of plate E, of 380 metres, is already so weak that it may be pretty safely concluded that the extreme limit could not be more than 20 metres lower. On the other hand, the experiments in the Lake of Geneva have shown that the dispersion of the sunlight by a light layer of clouds does not bring about a notable diminution in the depth which it may attain in the water.

It is concluded, then, from these experiments, that in the month of March, in the middle of the day, with a bright sun, the last rays of daylight stop at 400 metres from the surface in the Mediterranean.

3. *Effects of the Seasons on the Limit of Penetration of Daylight in the Waters of the Lake of Geneva.*

The experiments of M. Forel, mentioned above, showed that photographic paper dipped in the lake is blackened in winter to a depth of 100 metres, whilst in summer it is not blackened beyond 45 metres. It is interesting to know whether this variation of transparency with the season belongs only to superficial layers, or if the same law holds good also at lower levels.

March 18, 1885, the Commission went into the middle of the lake on the *Sachem*, steam yacht of M. E. Reverdin, which its owner put at their disposal. As in former experiments on the lake, M. Forel was present. The weather was pretty clear; a light layer of clouds dispersed the light without arresting completely the direct rays of the sun. The following plates were exposed: (*k*) from 9.20 to 9.30, at 158 metres; (*l*) from 10.0 to 10.10, at 192 metres; (*m*) from 10.30 to 10.40, at 235 metres; (*n*) from 10.10 to 11.20, at 240 to 245 metres; (*o*) from 11.48 to 12.23, at 280 to 300 metres.

The duration of exposure was uniformly ten minutes for all, save the last, which remained uncovered, at 280 metres, for 35 minutes. In spite of that, not the least trace of impression was visible either on this plate or on plates *m* and *n*. The plate *l* was very faintly impressed, almost like plate E, of 380 metres in the sea. Plate *k*, at 158 metres, is of nearly the same force as C.

These experiments show that the extreme limit of the action of daylight in the lake in winter is a little beyond 200 metres.

A comparison between this series of experiments and the preceding shows that the light only descends 20 or 30 metres lower in March than in September; the difference is perhaps a little more considerable in the month of August. The layers of water situated below 100 metres escape the law of variation of transparency established by M. Forel for the more superficial layers; the variations of temperature accompanying the seasons, on the effect of which M. Forel bases his theory, not being sensibly felt beyond a certain depth.

Compared to the series of plates exposed in the lake, the series brought from the Mediterranean is striking by its slower and more regular gradation. This gives rise to the idea that whilst in the lake the light is promptly intercepted by deep layers more or less troubled, in the Mediterranean the absorption of the pure water would be the principal if not the only factor in the arrest of the luminous rays.

4. *On the Penetration of Light in the Depth of the Sea at Different Times in the Day.*

The preceding experiments led to very exact determinations of the extreme limit of the penetration of daylight in the waters of the Lake of Geneva and in those of the Mediterranean.

The following year, pursuing the same kind of experiments, the relations which exist between the depth to which light reaches in the water and the inclination of the sun or the variations in the amount of light were investigated.

The Report continues :—

" As we no longer sought a single limit, but a series of limits at fixed times during the day, we required a series of plates exposed at the same instant at different depths and capable of comparison with one another. Instead of a single large apparatus, like that which we had been using, we used twelve small ones, constructed on the same principle, which we placed at regular intervals of 20 metres along the cord. These apparatus were also furnished by the Genevan Society for the Construction of Instruments in Physics. They consist of a little rectangular frame of brass, in which glides in double grooves the drawer containing the sensitive plate, and which an interior spring tends always to open. The frame is fixed by two rings of brass, which at their upper part allow the axis of rotation of a lever to pass. The apparatus is suspended to the sounding-cord by an arm of this bent lever, whilst the lower arm acts on a spring fixed to the

drawer. The lower part of the cord is attached to a cross-bar which unites the bottom of the two rings. When the cord is stretched under the action of the sounding-weight, the upper arm of the lever falls into the prolongation of the cord, in a vertical position, and the lower arm keeps the drawer close. When the action of the sounding-weight ceases, the drawer opens under the action of the antagonistic spring. The process is the same as in the large apparatus, but in a slightly different form, permitting a much smaller and lighter order, which is more suitable to the superposition in series. To avoid the lower apparatus interfering by their additional weight with the opening of the higher ones, when the action of the sounding-weight ceases, each apparatus and the corresponding cord were exactly counterbalanced by a floater of glass in the form of a vial, inclosed in a net and attached to the cord immediately below the apparatus which is wished to be free. Under these conditions the apparatus all open simultaneously, immediately that the sounding-weight touches the bottom, and also close all together at the moment when the cord is drawn up and the sounding-weight begins again to act on them. The simultaneous exposure of several plates at various depths is thus obtained, and it is possible to follow the decreasing action of the light with the depth in one and the same experiment, all circumstances being equal."

The sensitive plates used in these experiments were those of extra rapid gelatine-bromide of M. Lumière, at Lyons. They were protected by a varnish from the action of the sea-water. The duration of the exposure and that of the development were both ten minutes, as in the preceding experiments.

They were carried on in a locality presenting a depth of about 500 metres, so that the purity of the water and the limit of the light were not influenced by the nearness to the bottom. The place chosen was 1300 to 1500 metres from the Cape of Mont Boron, separating the strand of Villefranche from the Gulf of Nice.

Amongst the series of plates obtained the following succeeded well and are particularly instructive.

Series A.—Between 1.15 and 1.25, April 7, 1886, the sun being about 60° above the horizon. The sky was very clear and the sun brilliant ; a moderate breeze from the east made little waves.

Plate 1. Exposed at 430 metres: no trace of luminous impression.

Plate 2. Exposed at 390 to 393 metres: a very faint trace, but yet a clear one.

Plate 3. Exposed at 350 metres : a still faint impression.

Plate 4. Exposed at 310 metres : a strong impression.

Plate 5. Exposed at 270 metres : a very strong impression.

Plate 6. Exposed at 230 metres : completely blackened, as were the following.

The limit of light is, then, very exactly towards 400 metres in April, in the middle of the day, in fine weather. This is as complete a confirmation as possible of the conclusion arrived at in the preceding experiments.

Series B.—Between 8.20 and 8.30, April 5, 1886. Sky veiled by a uniform layer of white clouds thick enough for the sun to project no shadow. Moderate breeze from the east.

Plates 1, of 450 metres, and 2, of 415, have no impression.

Plate 3, of 350 metres, presents a very slight impression, a little less strong than that of plate 3 (390 metres) of Series A.

Plate 4, of 315, is of the same force as plate 3 of Series A.

Plate 5, failed by accident.

Plate 6, of 245, and the following, are completely blackened.

Series C.—Between 6.5 and 6.15, April 8. The setting sun was hidden by a bank of black clouds. The rest of the sky was pretty clear, with some little cirro-strati with a faint white light. The light was altogether faint, and like that which is generally found when the sun has just set. The surface of the sea was little agitated, with a slight breeze from the west.

Plates 1, of 400 metres, 2, of 340 metres, and 3, of 300 metres, have no trace of impression.

Plate 4, of 260 metres, is of almost the same force as plate 3 of Series A.

Plate 5, of 220 metres, similar to plate 4 of Series A.

Plate 6, of 180 metres, like plate 5 of Series A.

Plate 7 and the following, completely blackened.

The limit in this last series may be placed with all probability at 290 to 295 metres from the surface.

We see from these experiments that the layers situated at 300 metres are lighted every day, not for a very short time, but all the time that the sun is above the horizon ; at 350 metres the light penetrates at least during eight hours daily.

According to the tables that M. Holatschek has drawn up for the latitude of Vienna, especially after the photo-chemical experiments of MM. Bunsen and Roscoe, the actinic intensity of the light of the blue sky would be on April 21, 33 at 8.30 in the morning ; 38·07, at noon ; and 14·18 at 6 p.m. ; that of the sky and the sun at once would be on an average, in April, 75 at 8.30 a.m., 133 at noon, and 15 at 6 p.m.

According to these figures, the depth that the actinic rays attain in the sea after the setting of the sun is very remarkable. The Commission wait, however, to have more numerous experimental proofs to try to calculate a formula of absorption of which they have to determine the constant for sea-water.

5. *New Experiments on the Effect of the Seasons on the Limit of Penetration of Daylight in the Lake of Geneva.*

The results of these, which require to be confirmed under better conditions, seem to indicate that the difference of transparency between the waters of the lake in winter and in summer is greater than one would have thought. On the other hand, the want of agreement with the experiments of Series 3 leads one to think that the distribution in extent and depth of the layers of troubled water brought by the affluents of the lake is subject to variations difficult to foresee and to appreciate.

The Report concludes by referring to certain improvements in the apparatus.

THE REPORT OF THE KRAKATAŌ COMMITTEE OF THE ROYAL SOCIETY.

PART IV. of this Report, on the optical phenomena, by the Hon. F. A. Rollo Russell and Mr. E. Douglas Archibald, comprises 311 pages of letterpress, or the major portion of the work. Owing to the enormous mass of material which went on accumulating for nearly four years from the date of the eruption, as well as the complexity surrounding the optical phenomena, which in some cases were entirely novel, and in others differed both in quality as well as intensity from their normal analogues, it was plainly a work of some considerable difficulty to decide how best to arrange and discuss the data, as well as to avoid arriving at hasty conclusions from the first indications of appearances which continued in part right up to the beginning of 1887. When the wonderful sunsets appeared in this country, the idea of their being connected with the eruption of Krakataō was first suggested and traced out with remarkable clearness by Mr. J. Norman Lockyer, F.R.S., in his article in the *Times* (December 8, 1883).

From the results of certain experiments by himself, he

had concluded that, while under ordinary circumstances aqueous vapour preferentially stops by absorption the more refrangible blue rays, under certain circumstances somewhat analogous to the conditions under which the blue and red solutions of gold were obtained by Faraday, aqueous molecules exist which stop the red rays and transmit the blue. Such so-called "red molecules" were found to be larger than the "blue molecules."

Combining this with the facts which indicated an unusual extension of volcanic dust and vapour into the air by Krakataò, as well as the succession of dates, the occurrence of white suns in the Indian Ocean and blue suns at a distance and at noon, and the initially rapid progress of the coloured suns and twilight glows round the equator, and their gradual spread to the extra-tropics (at first only faintly realized through lack of sufficient data), he constructed the hypothesis that all the optical effects witnessed in England in November and December 1883 were, like those which preceded them, nearer the equator, traceable to the products of the August eruption of Krakataò, carried thither by the upper currents of the atmosphere. Although, in one or two minor details, such as a supposed south-to-north line of coloured suns over India, the vastly greater mass of evidence ultimately collected by the Committee enabled them to arrive at a more correct conclusion, yet, in its main features, such as the east-to-west current along the equator, and the concatenation of such at first apparently unconnected phenomena as a sunset in London and a volcanic eruption in Java, the work of the optical section of the Committee has practically resulted in filling in the framework sketched out by Mr. Lockyer. As time progressed, fresh data came pouring in, which not merely testified to the universality of the phenomena over the north and south temperate zones, but helped to fill up the gaps which necessarily occurred over the oceans and near the equator.

In spite of all these links in the chain of circumstantial evidence, many persons still continued to doubt the connection of the extra-tropical twilight glows with the analogous appearances in the tropics. In the case of the blue and green suns, the evidence even at first, was too strong to allow much doubt that they were in some way or other connected with the eruption. Yet even so, the rate at which they travelled (from 70 to 80 miles an hour) along the equator was too much for some persons, whose powers of imagination could hardly grasp the enormous scale on which the operations were conducted ; while in the case of the extra-tropics, all sorts of queer and gratuitous hypotheses were put forward to account for what they beheld from their own windows.

Now, a very cursory glance at the general data and evidence, as well as at the maps given in Section III., will, we think, convince the most sceptical that the grand series of optical appearances which were first seen in the neighbourhood of Krakataò on the day of its great eruption, extended themselves, at first rapidly in longitude, and then slowly in latitude, until they finally embraced the whole earth. It will also show that their arrival in Europe was but a mere incident in their spread over a region *fifty times as large*. All this, however, has had to be put forward in detail.

Other points which have had to be described or discussed were—

(1) The proximate cause of the abnormal twilights, and an explanation, as far as was possible, of the way in which they differed from ordinary twilights, both in quality and intensity.

(2) The coloured suns, large corona round the sun and moon, and the sky haze or eruption cloud which evidently caused them.

(3) Then came the geographical distribution, the height and duration of the glows, a list of analogous phenomena on former occasions, opinions put forward to account for

the present series, and finally a general analysis of their connection with the eruptions of Krakataò in detail, each of which demanded a separate section.

To give some idea of the principal facts and conclusions of this part of the work, we will commence with the abnormal twilights, considered as local phenomena.

The phases of ordinary twilights have been investigated with much attention by Kepler, Le Mairan, Dr. Hellmann, and Dr. von Bezold,[1] of whom the last discussed them with wonderful clearness in 1863, and showed that certain sequences of colour and intensity take place normally, which have apparently been entirely overlooked until the present series brought the subject again into notice.

Thus the normal sunset consists chiefly of a series of bands of colour parallel to the horizon in the west in the order, from below upwards—red, orange, yellow, green, blue, together with a purplish glow in the east over the earth's shadow, called the "counter-glow." As the earth's shadow moves upwards towards the zenith, and passes invisibly across it, a reddish or purplish glow suddenly appears above the coloured layers in the west, in a spot which previously appeared of a peculiarly bright whitish colour. This purple glow is substantially the "primary glow," or, more definitely, "*erste purpurlicht*." It is peculiar in appearing *above* the horizontal colours, and in not extending far on either side of a vertical plane through the sun and the spectator. As this glow sinks on the horizon and spreads out laterally, it forms the first red sunset. After its disappearance, under *favourable conditions*, a second edition of twilight colours analogous to the first commences, with a similar bright spot (*dämmerungschein*) out of which a second purple light appears to be suddenly developed, and sinks on to the horizon as the secondary or "after-glow."

These are the normal phases of a complete sunset according to Dr. von Bezold, and the present series only appear to be abnormal in exhibiting certain peculiar yellow and greenish tints, a less-defined boundary of the earth's shadow, together with a much greater brilliancy, extension, and duration of the first, and particularly of the second, purple glows. The horizontal layers were less conspicuous than usual, and the abnormal extension of the purple light made it appear as though there was an inversion of the usual order of tints from below upwards.

In order to explain these and other peculiarities which we have not scope to describe, Mr. Russell starts with the observed fact of a sky haze which, in the tropics, tended to transmit blue or green rays in preference to red, and assuming that all the usual elements which are included under the term "optical diffusion" were present, viz. diffraction, refraction, and reflection, describes what should be the effects (1) assuming a haze composed of opaque particles, and (2) one composed of very thin reflecting plates into which condition a large proportion of the pumice ejected from Krakataò is shown to have been transformed. His conclusion is that the distinctive features of the Krakataò glows were due mainly to reflection from these fine laminæ, of rays already tinted in a certain order, by diffraction through the dust of the haze layer and the lower atmosphere, as well as by the selective absorption which ordinarily takes place in the more humid horizontal layers near the earth's surface. The direct as well as diffuse reflection by the plates and opaque dust, which lay, as Mr. Archibald has shown in Section IV., at a height of from 50,000 to 100,000 feet, of rays tinted in succession as both the direct and reflected twilight boundaries followed the descending sun, and the peculiar transmissive quality of the stratum for the more refrangible rays, appear to afford a reasonable explanation of the peculiar silvery glare, the unusual colouring, and the unusual extension of the purple glows.

It is admitted that diffraction played an important part, as it does in ordinary sunsets (Lommel, for

[1] *Pogg. Ann.*, Bd. cxxiii. (1863), pp. 240-76.

example, attributes all the red tints to this cause) ; but both in this section and those that follow, many considerations are urged against the view held by Prof. Kiessling that the development of the primary glow is chiefly due to diffraction, while the secondary glow is as confidently asserted to be due to reflection. One of the principal objections to the reflection hypothesis in explanation of both the ordinary as well as the present extraordinary development of the purple glow, is its limitation at first to a narrow band, a fact which cannot be explained by absorption, and which is equally at variance with Fresnel's law of reflection from small globular dust, which would be equal in all directions. On the lamina, and particularly the vitreous lamina assumption, however, it is intelligible, since the maximum reflection would then be like that from the sea, in the vertical plane through the sun and the eye.

Moreover, the richly coloured and prolonged secondary glows, which were the most characteristic feature of the Krakatao twilights, are shown by Mr. Archibald, in Section IV., when dealing with their secular duration, to have reached a distinct minimum when the large diffraction corona round the sun, from Prof. Ricco's observations,[1] appeared at its greatest brilliancy ; while the curve of their duration on Plate XXXIX., representing Dr. Riggenbach and Mr. Clark's observations, shows that they never again reached the same brilliancy or duration as in the two or three months immediately succeeding their first appearance in Europe. Both these facts aid the conclusion arrived at by Mr. Russell, and indorsed by Prof. Kiessling, that they were reflections by the haze stratum of the primary glows. But if these were reflections, the question naturally arises, why not the primary also ? and until more effective arguments are brought against this view, as well as Prof. Ricco's objections to Prof. Kiessling's theory of diffraction alone, which are detailed in Section I. (*c.*), p. 250, Mr. Russell's view of the origin of both glows seems to be the more probable as well as reasonable of the two. The haze stratum appears to have been capable of exerting two influences : one, diffraction of the sun's rays by its smallest particles, which, with the absorption and diffraction usually effected by the dust and vapour present in the lower atmosphere, caused the horizontal tinted layers ; the other, reflection by its larger particles or laminæ of the horizontal layers, particularly of the lowest red one, when the earth's shadow had arrived at about 25° above the western horizon, and into a position whence the maximum reflective effect could be seen unmasked by a diffusely illuminated background.

The question of the blue and green coloration of the sun is next discussed by Mr. Archibald, particularly with reference to its intrinsic characteristics and physical origin. In Section VII., in which the distribution of the twilight glows and the blue suns on their first circuit of the globe is compared, it is shown that the mean limit of the band of coloured suns was about 11° north and south of the latitude of Krakatao right round the equator, while that of the glows lay 5° beyond this on either side. Along the latitude of Krakatao the colours were mostly white or silvery, and in one or two cases coppery. The colours thus evidently depended on the density of the stream, the glows appearing on its borders or fringes where it was less dense. A similar relation to density appears from a study of the diurnal changes with varying solar altitude, the sun appearing to change from blue near the zenith, through green, to yellow, or disappearance on the horizon. No direct physical explanation of such a phenomenon appears forthcoming, since, according to the physical laws enunciated by Lord Rayleigh and Prof. Stokes, the diffraction of light by particles of the same order of magnitude as a wave-length tends to sift out the shorter blue, and preserve the longer red waves of light. Repeated reflections by small particles tend to the same result.

[1] Section I. (*c.*), p. 241.

The explanation proposed by Mr. Norman Lockyer in his article in the *Times* attributed the blue colour of the sun to differences in absorbing power of particles of different sizes, the larger particles being supposed to transmit more of the rays near the red end of the spectrum and the smaller those of shorter wave-length. The difference of size has been shown by Prof. Kiessling to be inoperative so far as scattering is concerned, since for particles whose magnitude is of the same order as that of a wave-length of light, the only case to which Prof. Stokes's law applies, the intensity of the scattered blue rays will be always sixteen times that of the red rays. It can therefore only be explained as an effect of absorption, due to some particular absorptive property of the materials which composed the haze. The phenomenon of a blue or green sun has been observed under natural conditions, many of which are quoted, and in most cases where the air was filled with fine dust from a great variety of sources. It has also been artificially reproduced by Prof. Kiessling with dust-filled air and vapour of water, and particularly of sulphur. Several accounts are given in Section V. of blue suns seen in connection with former eruptions, and Mr. Whymper's observation during an eruption of Cotopaxi is conclusive as to the ability of the finest volcanic ejecta to cause such an appearance. The problem which still awaits solution is, What was the precise nature of the particles or gases which produced the absorption ? It seems probable that they were metallic sulphides.

Mr. Archibald next deals with the sky haze and its peculiar effects, more particularly on astronomical definition. Here again it seems to have possessed a selective absorption of the red rays, for in two separate lunar eclipses, 1884 and 1885, the usual coppery tint of the moon was conspicuously absent. He then passes on to the peculiar large corona round the sun and moon, which was first observed by Mr. Bishop at Honolulu on September 5, and which, though less striking than the twilight glows, was, if anything, more uncommon, more constant, and more prolonged in duration. It was a true diffraction corona with a reddish border, and of almost exactly the same size as the ordinary ice-halo, viz. 45° in diameter. It lasted from September 5, 1883, up to October 15, 1886, since which date it has entirely disappeared. Its diameter has afforded an approximate determination of the mean radius of the smaller dust-particles composing the haze, which Mr. Archibald calculates to be 0·00006 of an inch. Its connection with, and independence of, the glows is discussed at length, but we have not space to refer to it.

In Section II., Mr. Russell gives a list of the first appearances of all the optical phenomena from the beginning of 1883 to the end of 1884, from which date the local duration of the glows is carried on by Mr. Archibald in Section IV. up to the end of 1885.

In Section III., Mr. Russell works out the geographical distribution of the optical phenomena, including blue suns and glows, up to the end of 1883, by which time they had virtually covered the whole earth. The general conclusion is, that the phenomena all propagated themselves (with the exception of a narrow offshoot towards Japan) at first due west from Java, at a rate of about 76 miles an hour right round the earth parallel to the equator, and in a band symmetrically disposed for 16° on either side of the latitude through Krakatao. A second circuit with wider limits, 30° north and south of Krakatao, was traced at the same rate, after which the motion became indistinguishable. They then gradually spread in latitude, and ultimately the haze which caused them appears to have invaded our latitudes, like the anti-trade, from south-west to north-east. These circumstances may be best realized from a survey of Mr. Russell's maps, especially that showing the successive limits of the appearances for the first nine days succeeding the eruption.

When Mr. Lockyer first pointed out his lines of coloured suns converging towards Krakataō, the data were too scanty for him to recognize that the apparent line through Ceylon, Ongole, and Madras, was due to a widening of the main east to west stream after its first circuit of the globe. As far as the motion of this stream was indicated by African and South American observations, he was perfectly correct, though nothing was previously known as to its velocity or even actual existence. The march of the optical phenomena which is shown in Mr. Russell's maps is indeed the only direct evidence we have of the fact that at 100,000 feet above the earth in the immediate vicinity of the equator, the air in August, and probably, as Mr. Archibald shows, at other times, moves in a rapid and constant current from east to west. Both in Section III. (*b*) and Section VII. he discusses this question in detail, and shows its agreement with the theory of the general circulation of the atmosphere, as well as the motions of the upper clouds as far as they have been observed.

In Section IV., Mr. Archibald investigates the height of the stratum, from observations in all parts of the world where the durations of the primary or secondary glow have been recorded with any attempt at accuracy. Proceeding on the hypothesis that the primary glow was a first reflection of the sun's rays by the stratum, and the secondary a reflection of the primary glow, for which ample evidence is adduced, he concludes that the height of the upper or middle part of the stratum above the earth, diminished from 121,000 feet in August 1883, to 64,000 in January 1884, the lower limits being practically indeterminate. Also, since from Dr. Riggenbach's and Mr. Clark's observations, the glows continued less brilliantly and less prolonged after the first few months right up to the end of 1885, while a decided minimum in the duration, and therefore presumably the height of the reflecting layer, was reached in April 1884; the important conclusion is arrived at, that by that date the larger and more effectively reflecting particles had descended to a lower level, leaving the finest particles suspended at nearly the same elevation as at first. This is further corroborated by the remarkable fact that the large corona reached its maximum intensity during the same month.

In Section V., Mr. Russell gives an interesting list of former eruptions and accompanying atmospheric effects, similar in many respects to those under discussion. During 1783 and 1831, the dates of the famous eruptions of Skaptar Jökull and Graham's Island, &c., and the two years of perhaps the greatest eruptive activity antecedent to that of Krakataō, the *after-glows* and other optical effects were most conspicuous, and from an examination of other eruptions and sequelæ, the general correspondence between the two phenomena seems fairly proven.

Section VI. is a *résumé* of opinions collected by Mr. Archibald, against and in favour of the volcanic origin of the phenomena. Besides its value in exhibiting every aspect of the question, it affords a curious illustration of the narrowness and breadth of human imagination, especially when dealing with phenomena whose universality and minor details were at first only partially realized.

Finally, in Section VII., Mr. Archibald gives a general analysis of the connection between all the optical phenomena and the eruptions of Krakataō both in May and August, in which the various objections on the ground of the initially rapid transmission of the appearances, insufficiency of fine solid ejecta, length of time of its suspension, and the occurence of *apparently* similar phenomena on dates previous to the great August eruption are discussed in turn. The time of suspension of the finest dust in particular, is shown—by an application of Prof. Stokes's formula,[1]

[1] Where σ, ρ, are the densities of the particle and the fluid respectively, a the radius of the particle (supposed spherical), and μ' the index of friction $= \frac{\mu}{\rho}$, where μ is the coefficient of viscosity. Its value is either $(0.116)^2$ or $(0.14)^2$.

$$V = \frac{2g}{9\mu'}\left(\frac{\sigma}{\rho} - 1\right)a^2,$$ for the velocity of a small particle descending in air, and in which viscosity is properly considered—to be *over two years* between 50,000 and 100,000 feet, even assuming the particles to be spherical, which is the most unfavourable supposition. If, as is most probable, they were thin plates, the time would be much longer. A final summary is then given of the direct and local connection between the optical phenomena and the eruptions both of May and August, which the subsequent discovery of the relative though minor importance of the May eruption rendered necessary.

In Part V., Mr. Whipple discusses the somewhat sparse data which show that a magnetic disturbance was generated by Krakataō and travelled round the world at a rate varying from 760 to 900 miles per hour, but the data are too uncertain to allow any definite conclusions to be drawn.

We cannot conclude without drawing attention to the fact that the study of the Krakataō sequelæ has not merely enlarged our conceptions of volcanic powers and the continuity of atmospheric circulation, as well as yielded positive information of great value to different branches of science, but has opened up fresh problems in optical and meteorological physics, the attack and solution of which will stimulate research as well as materially advance the boundaries of our present knowledge of these subjects.

SCIENCE AND THE REPORT OF THE EDUCATION COMMISSION.

THE Final Report of the Commissioners on the Elementary Education Acts, which has excited so much attention of late, deserves to be noticed from a point of view other than any that has yet been taken—that is, the attitude of the Commission towards the teaching of science in elementary schools. In a rather lengthy chapter on "Manual and Technical Instruction," the ground taken by the Commissioners is very clear. The teaching of science in our elementary schools, they say, is yet in its infancy. The importance of science teaching has been so far recognized that simple object-lessons are obligatory in all infant schools. This is a mode of teaching which the Report recommends to be extended. Thus in agricultural districts arrangements could be made for giving practical instruction of the simplest character in the principles of agriculture, the growth and food of plants, and their diseases ; and similar instruction in the elements of dairy work might be given to the girls in these districts. The point here laid stress on is one that everybody who knows anything of former attempts to teach science to the children in Board-schools will feel the need of. Science, the Commissioners emphatically say, can never be taught to children out of books alone. No doubt much useful and entertaining knowledge is taken from text-books on science by children ; but, to use the words of the Report, the true learning of science cannot be said to begin till the learners are taught to use their own senses in the study, and to rest their acceptance of scientific truth, even the most elementary, not on what they are told, but on evidence supplied by their own observation. To show the curious system of instruction pursued in our schools, it is worth while mentioning that though those simple object-lessons which lie, we are told, at the foundation of scientific instruction are compulsory in infant schools, yet immediately the child leaves the infant school they are discontinued until he reaches Standard V., after which, if he ever gets any scientific teaching, it is out of books alone. One witness considered it ridiculous that English is compulsory and elementary science optional, for, he said, English includes grammar and recitation for boys, the latter of which, he thinks, is far less likely to be useful in a manufacturing district than

elementary science. The preponderance of opinion amongst the teachers examined is that no subject is better calculated to awaken the interest and the intelligence of the scholars than science. So far as the present teaching of elementary science is concerned, it is in a most unsatisfactory condition. Mr. J. F. Buckmaster says that, in comparison with forty years ago, this department of school work has retrograded ; and Sir Henry Roscoe agrees with the statement that the teaching of this subject is falling off. According to the latter witness, our system of education is intended to form clerks and not artisans : it is purely a literary system ; and if we wish to preserve our manufacturing supremacy it must be changed. In fact, whatever has been done by the manufacturers and artisans of this country is owing in no degree whatever to the educational system, which rather retards industrial progress than otherwise ; whilst on the Continent, where manufactures have made such strides of late, everything is owing to the technical schools and the scientific training of those intended for artisans. The vast majority of Board-school boys are intended for the workshop rather than the office : why, then, not fit them for the ordinary duties of life ? If this be the object of elementary education—that is, the fitting of scholars in general for those duties which they will most probably be called on to perform—then, the Report says, elementary instruction in science is only second in importance to elementary instruction in reading, writing, and arithmetic. But the fact is, that though girls get some kind of training in, for example, needlework and cookery, there is no such thing as technical instruction for boys. Science, especially mathematical, mechanical, and physical science, is not only the foundation, but an essential part of technical instruction. With regard, however, to the teaching of science, certain warnings are necessary. In the first place, science teaching should not be allowed to interfere with the scholar's general instruction—that is, it should not be introduced too early in life. In the next place, the average teacher is useless as a science master. Even when by previous training the teacher is suited, he has scarcely time to devote to the preparation necessary to lecture clearly and to perform experiments accurately and neatly. Therefore, the Report suggests, the example of London, Liverpool, and Birmingham should be followed by School Boards, in engaging the services of a skilled science lecturer, who will go from school to school in a specified district. For example, in Birmingham, according to the evidence of Dr. Crosskey, the Chairman of the School Management Committee of that town, the demonstrator or an assistant visits each boys' and girls' department once a fortnight. He takes four departments a day, two in the morning and two in the afternoon. Two and a half hours a fortnight are given to science. The class teacher is present during the lecture, and recapitulates it to his scholars, who are bound to bring him written answers to questions thereon. Mechanics or elementary natural philosophy are the favourite subjects with boys,—sometimes they are taught electricity and magnetism ; and the girls, domestic economy, considered as the application of chemistry and physiology to the explanation of matters of home life, and sometimes animal physiology. Not only have very great results been achieved by this system in the percentage of passes, but it is noticeable that the attendance is always largest on "science" days. Three years ago a lecturer was appointed for the East End of London, and he had at one time as many as two thousand boys under instruction in mechanics alone. The work has been so successful that three assistants have been appointed. Many witnesses justly complained of the kind of examination papers set in elementary science. One paper of questions is given at length in the Report. It is for boys of the Fifth Standard—that is, for boys between eleven and twelve—and consists of seven questions, of which a specimen, taken at random, may be given : "Quest. 2. In what bodies

may you say that molecular attraction is balanced by the repulsive force of heat ? " and written answers had to be given. Hence the suggestion of many experienced witnesses that younger children should be examined orally is taken up and recommended by the Commission.

Our system, or rather want of system, of education in elementary science is spoken of by the Commission as introductory to the wider subject of manual and technical instruction, to which they devote many pages of their Report. Into this we shall not follow them, but content ourselves by quoting a few sentences from the Report. " If it should be thought that children ought to receive some instruction in manual employment, other than that which the elementary schools available for their use can give, we are of opinion that the best way of meeting the need would be through the establishment of a workshop in connection with some higher institution, which might be willing to receive into the workshop boys of exceptional ability, or others to whom it was considered desirable to give this instruction. One such central institution could do its work better and cheaper than a number of scattered institutions, whilst nothing could be easier than to make arrangements for attendance at this central workshop being substituted on one or two afternoons in the week for attendance at the elementary school." To illustrate what might be done in this way, the case of the Seventh Standard School at Birmingham is quoted. This is to some extent a technical school, and no pupil is admitted unless he has previously passed in Standard VI. The subjects taught are reading, writing, and arithmetic, according to the Code ; and, in addition, mathematics, plane geometry and projection, machine construction and drawing, magnetism and electricity, theoretical and practical chemistry, freehand drawing, and the manipulation of wood-working tools. These subjects are not generally taught to all pupils, but are divided into three divisions, to one of which, as a rule, the student confines his attention. The first division is the machine construction division, and includes mathematics, projection, machine construction, electricity, freehand drawing, and workshop ; the second division is the chemistry division, and includes mathematics, projection, chemistry (theoretical and practical), freehand drawing, and workshop ; the third division, the electricity division, includes mathematics, projection, theoretical chemistry, electricity, freehand drawing, and workshop. In the second year (the course is three years in duration) the scholars spend three hours a day in the workshop. This system, it is said, has produced excellent results.

NOTES.

THE Council of the Royal Meteorological Society have arranged to hold at 25 Great George Street, Westminster (by permission of the Council of the Institution of Civil Engineers), on March 19–22 next, an Exhibition of Instruments connected with atmospheric physics invented during the last ten years, especially those used for actinic and solar radiation observations. The Exhibition Committee invite the co-operation of all who may be able and willing to send contributions. The Committee will also be glad to show any *new* meteorological instruments or apparatus invented or first constructed since last March ; as well as photographs and drawings possessing meteorological interest.

WE learn that Prof. Fitzgerald and Mr. Trouton have been conducting experiments confirmatory of Hertz's magnificent work. Lately, using parabolic mirrors after the manner Hertz recently described, they have observed the phenomenon of the polarization of radiations by reflection from a wall 3 feet thick. They observed long ago, and exhibited publicly at the opening meeting of the Experimental Science Association last November, that stone walls are quite transparent to these radiations, as they

should be, and consequently should not reflect radiations polarized perpendicularly to the plane of incidence at a certain incidence. This is what has been observed, and it has been decided that the plane of polarization is the plane of the magnetic disturbance. They next tried reflection from sheets of glass, and obtained no results ; but, as Mr. Joly suggested, the experimenters were practically observing the black spot in Newton's rings, for the sheet of glass was much thinner than a wave-length, which is about 30 centimetres. Some rough observations at various incidences from the wall seem to show interference at some and not at other incidences due to the same cause as Newton's rings.

THE German Government have granted the sum of £27,500 to repair the building of the University of Berlin, and to erect new lecture-rooms, staircases, and corridors, and for the heating and lighting apparatus. The Government have also given £36,500 to the Natural History Museum, besides £2500 for books. A further sum of £1000 is to be devoted to the purchase of physical apparatus and an anatomical cabinet.

AT the Epidemiological Society, on February 13, Mr. Victor Horsley will read a paper, illustrated by lantern photographs and micro-photographs, on " Rabies, its Treatment by M. Pasteur, and its Detection in Suspected Cases."

A TECHNICAL LABORATORY for special instruction in dyeing and bleaching has just been opened in connection with University College, Dundee. This technical portion of the chemical department consists of a completely fitted dye-house, a laboratory, and a museum for technical samples, more especially connected with the textile industries of the district. Practical instruction in the dye-house was begun by Prof. Percy Frankland last week.

THE *Kew Bulletin* for February consists of a list of such hardy herbaceous annual and perennial plants as have matured seeds under cultivation in the Royal Gardens, Kew, during the year 1888. These seeds are available for exchange with colonial, Indian, and foreign botanic gardens, as well as with regular correspondents of Kew. The seeds are for the most part available only in moderate quantity, and are not sold to the general public. The compiler points out that, as compared with the list previously published (*Kew Bulletin*, February 1887), the number of names inserted in this list is far fewer. This, he says, has arisen on account of the unfavourable conditions experienced during the summer of 1888, when, owing to prolonged rains and absence of sunlight, many plants did not mature seed.

WE learn from *Petermann's Mitteilungen* for January that a Central Meteorological Institute was established on April 7, 1888, at San José, Costa Rica, under the Ministry of Instruction, with Señor Pittier as Director.

AN Intercolonial Meteorological Conference was held at the Melbourne Observatory from September 11–15 last, under the presidency of Mr. R. J. Ellery, all the Australian colonies, New Zealand, and Tasmania, being represented. The Chairman stated that the chief object of calling the Conference together was "with a view of improving the intercolonial weather system, and for the advancement of Australian meteorological science generally." The following are among the principal resolutions adopted : (1) that the amount of information sent by telegraph should be reduced as far as possible, by reducing the number of stations ; (2) that, with the telegrams, a forecast be sent from each colony for that colony ; (3) that no meteorological forecast or prediction made in one colony and having reference to any other colony shall be communicated by telegraph to any other person or destination than the meteorologist of the colony to which such prediction refers. This motion was carried with

one dissentient, Mr. Wragge. A long discussion ensued as to the best mode of thermometer exposure. Mr. Todd stated that he had fully tested the Stevenson stand ; he thought it was quite impossible for anyone to say positively what was the best form of exposure. He was going to adopt the Stevenson screen for his out-stations, but was not necessarily going to put it only 4 feet from the ground. The Conference generally agreed that they should all work towards uniformity in the matter as far as possible. On the question of the supply of self-registering instruments to certain stations, Mr. Russell said that he had found the most diverse results from Richard's instruments ; some gave satisfactory results, and others were perfectly useless. Sir James Hector said he had been fortunate with the instrument ; as an assistant to reading the weather, it was most efficient. On the question of cloud nomenclature the forms given by Mr. Abercromby were approved of ; the Chairman urged the importance of having them lithographed in colours, and he undertook to get copies of Mr. Abercromby's photographs so prepared, and sent round for approval to the members of the Conference. Various other questions were discussed, including the connection of climatological observations with hygiene, and the reduction of barometer observations to sea-level.

FRENCH students of ethnography are much interested in the group of Lapps who are at present being exhibited at the Jardin d'Acclimatation, Paris. The other day the group was increased by one, a daughter having been born. The new-comer is called " Parisienne."

THE Geographical Society of Paris has just opened an interesting exhibition of photographs, dresses, weapons, boats, and other objects brought a short time ago from Greenland by M. Charles Rabot.

FOR many years the Kazan Society of Naturalists has devoted a good deal of attention to its collection of skulls, which is now one of the richest collections of the kind in Russia. Dr. Malieff gives, in the Memoirs of the Society (vol. xix. 2) a catalogue of the collection, with the chief measurements and indexes of each skull separately. The Slavonian and Russian skulls—partly from the seventeenth and eighteenth centuries, and partly more recent—are the most numerous ; they number about three hundred. The old Bulgarian skulls, represented by thirty-seven examples, come next. The Permians, the Votyaks, the Tchuvashes, and the Tcheremisses are well represented. The like may be said of the Mordovian and the old Finnish skulls derived from the grave-mounds (*kurgans*). The Tartarian skulls are represented both by samples found in *kurgans*, and by modern specimens. Eighteen Kazan skulls found at Astrakhan are especially worthy of note.

RUSSIAN botanists are busily exploring the floras of the various divisions of the Empire, and the number of floras of separate provinces is rapidly increasing. At the same time, they are devoting closer attention to the delimitation of the various floras of European Russia, their chief efforts being directed towards the establishment of the separation lines between the flora of the black-earth or steppe region, and the flora of the forest region. M. Korzchinsky's new work on the northern limits of the former in the Government of Kazan, accompanied by a map which illustrates the conclusions of the author, is a valuable contribution to the subject (Memoirs of the Kazan Society of Naturalists, vol. xviii. 5). Full lists of the species characteristic of separate districts are given, together with a review of the literature dealing with the phenomena. Contrary to views formerly maintained, the author holds that in Eastern Russia there is no such separate flora as might be considered intermediate between the forest and the steppe

floras, and that the latter penetrates within the forest region in the shape of isolated and well-defined oases; while a mixed vegetation, containing species characteristic of the steppes, intermingled with representatives of the meadows of the forest region, is met with only sporadically on the banks of some rivers, on the southern slopes of some hills, or on the outskirts of the forests. He distinguishes, on the contrary, a vegetation which has its own special characters over very wide tracts—from Astrakhan to Yaroslav—and is met with on the banks of the Volga, Kama, and Vyatka, as well as on the banks of the lakes which formerly were connected with the rivers and their old beds.

THE *Annuaire du Bureau des Longitudes* for 1889 contains the usual astronomical and physical tables, and much useful information relating to meteorology and other subjects. There is an admirable list of variable stars, with their positions corrected for 1889, and the dates of maxima and minima. The particulars of cometary orbits are brought up to Olbers's comet of 1887. With the exception of the memoirs at the end, however, there is little novelty. M. Tisserand contributes a very useful paper on the measurements of the masses of celestial bodies, including planets, asteroids, satellites, comets, and binary systems; a better account of the application of the laws of gravitation to this purpose would be difficult to find. Perhaps the most interesting paper is that contributed by M. Janssen, on his memorable expedition to Mont Blanc for the purpose of deciding whether certain lines in the solar spectrum are due to oxygen in our air or in the solar atmosphere. The results of the observations made on Mont Blanc showed that these lines were due to our own atmosphere, as they were weaker there than at lower levels.

WE have received the *Annuaire de l'Académie Royale de Belgique* for 1889, this being the fifty-fifth year of publication. Besides the academical calendar for the year, it contains a general history of the organization and all particulars relating to each department. It also gives accounts of the Commissions delegated to superintend the publication of national biography and history. Details of the prizes and medals at the disposal of the Academy, and the recipients of them from the dates of their institution, are also given. About 340 pages are devoted to biographical notices of deceased members, which are accompanied by admirable portraits, and full particulars of the works of each. It is interesting and gratifying to note the frequent occurrence of "Leopold II., Roi de Belgique," in connection with the work of the Academy.

ANOTHER important paper is contributed by Prof. Emil Fischer and Dr. Tafel to the number of the *Berichte* just received, upon the syntheses of glucose and mannite. Not only has the method of synthesizing glucose been perfected, and large yields of it obtained, but it has also been shown to ferment with yeast like natural glucose, and also like glucose to yield, on reduction with sodium amalgam, the hexhydric alcohol mannite. The first process by which the synthesis was effected, and which was fully described in NATURE, vol. xxxvii. p. 7, consisted in treating acroleïn dibromide with baryta-water, the sugar left in solution being afterwards precipitated by phenyl hydrazine in the form of a peculiar compound with the latter substance of the composition $C_{18}H_{22}N_4O_4$. This phenyl hydrazine compound was then reduced with zinc dust and acetic acid, the product being a base which, on treatment with nitrous acid, parted with its nitrogen, leaving a solution from which glucose was extracted by means of absolute alcohol. This method of obtaining glucose from the phenyl hydrazine compound was both exceptionally difficult in manipulation, and gave a very small yield of the sugar. The Würzburg chemists have recently discovered a far better process. The finely-powdered phenyl hydrazine compound is warmed with concentrated hydrochloric acid, when it dissolves to a clear dark red liquid. On cooling, phenyl hydrazine hydrochloride crystallizes out and is filtered off. The diluted filtrate is neutralized with hydrated lead carbonate, decolorized with animal charcoal, again filtered, and the solution made slightly alkaline with baryta-water. A syrupy substance of the constitution $CH_2OH . (CHOH)_3 . CO . COH$, which differs from glucose in possessing two atoms of hydrogen less, is at once precipitated in combination with lead. The precipitate is next treated with sulphuric acid and again neutralized with barium carbonate. The filtered solution, at last obtained almost pure, is evaporated *in vacuo* upon a water-bath, and the syrup extracted with absolute alcohol; on evaporation of the alcohol, the syrup is left behind in the pure state, and solidifies on cooling to a hard amorphous mass. It is only necessary now to reduce the aqueous solution of this syrup with zinc-dust and acetic acid, when the two additional hydrogen atoms are taken up and glucose formed. The zinc is precipitated from the filtered liquid by sulphuretted hydrogen, and the filtrate evaporated *in vacuo* upon the water-bath. On extraction of the syrup with absolute alcohol, and subsequent addition of ether, the sugar is precipitated in colourless flocculæ, which rapidly coalesce into a sweet-tasting syrup of pure glucose. By this method so large a yield has been obtained that fermentation experiments have been possible; and with beer-yeast this artificial glucose is found to rapidly ferment, evolving abundance of carbonic anhydride at the ordinary temperature. It reduces Fehling's solution, and only differs from natural dextrose and lævulose in being optically inactive, consisting, as it probably does, of a mixture of equal molecules of the right- and left-handed varieties. Further, by action of sodium amalgam, it is readily reduced to a compound of the formula $C_6H_{14}O_6$, which crystallizes in fine plates and melts at 165°; in fact, possesses all the properties of the hexhydric alcohol, $C_6H_8(OH)_6$, mannite.

THE *Board of Trade Journal* publishes a memorandum which has been drawn up in the Fisheries Department of the Board of Trade relative to the Sea Fisheries Regulation Act, 1888. The memorandum says that the Board of Trade may on the application of any county or borough Council create a sea fisheries district, and define its limits, and provide for the constitution of the local committee, which body is to have power to make by-laws regulating sea-fishing and oyster-fishing, to impose fines and forfeitures for the breach of such by-laws, and to appoint fishery officers for enforcing the observance of the by-laws within the district. Fishery officers will be empowered to search any vessel or vehicle used in fishing or in conveying fish.

THE *Zoological Record* for 1887 has just been issued. The editor is Mr. Frank E. Beddard. He explains that the only alteration of importance in the present volume is that authors' names have been printed throughout in capitals. It will be found that this renders clearer the references in the systematic part of the several records.

WE have received the first number of *Art and Literature*, published by Messrs. Maclure, Macdonald, and Co., Glasgow. It is well printed and illustrated, and the only fault we have to find with the new venture is that the word "Science" is not included in the title.

THE fourth part of Cassell's excellent "New Popular Educator" has been issued. This part, which contains contributions to the study of geography, physical geography, physiology, astronomy, and other subjects, is accompanied by a map of England, and is well illustrated.

A VALUABLE bibliography of Indian geology has been compiled by Mr. R. D. Oldham, Deputy Superintendent of the Geological Survey of India. It contains a list, as nearly complete as possible, of books and papers relating to the geology of British India and adjoining countries, published previous to the end of the year 1887.

ARNOLD GUYOT's " Earth and Man " has been recently published for the first time in French. The French edition is not a rendering from the English ; it is the original from which the English edition was translated.

AT the monthly meeting of the Royal Institution of Great Britain, on February 4, the special thanks of the members were returned to Mr. William Anderson for his present of a portrait of Prof. Mendelejeff.

IT is reported from North Central Norway and Sweden that wolves are very numerous this winter. They have reappeared in districts where they have been unknown for many years.

THE beaver is getting very scarce in Sweden, but recently a colony has been discovered near the mountain Middagsfjeldet, in the province of Jemtland, in the heart of Sweden.

IT is reported from the districts around the Christiania Fjord that sparrows have almost completely disappeared from those parts this winter.

SOME French students in Paris are distinguishing themselves by wearing a peculiar cap, the *bérét* of the Pays Basque, to which is joined a small badge, varying in colour according to the Faculty or School (Scientific, Literary, Law, Medical, &c.) the possessor belongs to. The students of Montpellier have been better inspired in reviving the cap worn in the old school at the time of Rabelais.

WE have received the Calendar for the current academical year of the Imperial University of Japan. The record of events for the past year notes that in June the Tokio Observatory was founded. It is formed by the amalgamation of the University Observatory, the Astronomical Section of the Home Department, and the Astronomical Observatory of the Imperial Navy ; the whole being placed under the control of the University, which is now intrusted with the duty of publishing the Astronomical Almanac. By a new arrangement, also, the income of the University from tuition fees and other minor sources is for the present to be accumulated year by year with the object of forming a capital fund for future use. The same is to be done with the fees of other educational institutions under the Education Department. At the time when the Calendar was issued, 276 students were attached to the Faculty of Law, 246 to that of Medicine, 91 to Engineering, 45 to Literature, and 36 to Science. The total number of graduates was 954.

THE additions to the Zoological Society's Gardens during the past week include a Golden Eagle (*Aquila chrysaëtus*), European, presented by Mr. Thos. Barclay ; an Alligator (*Alligator mississippiensis*) from Florida, presented by Mrs. G. Peacock ; two Himalayan Monauls (*Lophophorus impeyanus*) from the Himalayan Mountains, deposited ; an Aard Wolf (*Proteles cristatus* juv. ♂) from South Africa, purchased.

OUR ASTRONOMICAL COLUMN.

THE COLOURS OF VARIABLE STARS.—In his new Catalogue of Variable Stars, noticed in NATURE, vol. xxxviii. p. 554, Mr. S. C. Chandler gave to each star a number indicative of the depth of the red tinge in its light, and in a more recent paper he has explained how these numbers were obtained. Two independent methods were followed : the first, the one proposed by Klein, and adopted by Schmidt and Dunèr, in which the stars were arranged according to a scale on which o corresponded to pure white light, 1 to the slightest perceptible admixture of yellow with the white, and so on with 4 for full orange, and 10 for the purest red light known to us amongst the stars, and as seen in such examples as R Leporis. In spite of the vagueness of the definition of this scale, Mr. Chandler found by experience that the process of thus referring the impressions of colour to these imaginary standards could be effected with greater precision than he had supposed, or would naturally be inferred by an observer previous to trial. His second method seems, however, to promise more precision, and is both simple and ingenious. It consisted in estimating the relative change in brightness effected in two stars by the interposition first of a blue, and then of a red, shade-glass. Thus, supposing a red and white star appeared of the same brightness when viewed without any shade-glass, the white star would seem decidedly the brighter when the blue glass was used, but the fainter when the red glass was interposed, and these differences could be very precisely estimated by Argelander's method, and thus afford definite measures of the differences in colour of the two stars ; of course, on an arbitrary scale depending upon the shade-glasses employed. In all, 665 estimates upon 108 telescopic variables were made by the first method, the "decimal scale" method ; and 287 "relative diminution estimates," as Mr. Chandler terms his second method, were made upon 77 of the same stars. The mean of the two methods, equal weight being given to each separate observation, was given as the value of the redness of the star in the Catalogue.

Two somewhat important results appear from these observations : first, that the observations are evidently not affected by any serious systematic error depending on the magnitude, for on the average the same colour is given both at maximum and minimum, the recorded differences being small in amount and of varying sign. It would appear, therefore, that the change in the magnitude of a variable does not usually involve a change in its colour. This is an important point, as the more general opinion hitherto has been that such a change does generally take place. The second result is the intimate connection that exists in a variable between length of period and depth of colour. The Algol type stars are strikingly white ; the very short-period stars are colourless, or nearly so ; and those of longer period show a deeper red the greater the duration of their periods.

NEW MINOR PLANETS.—A new minor planet, No. 283, was discovered by M. Charlois, of the Nice Observatory, on January 28. This is M. Charlois's fourth discovery.

COMET 1888 *e* (BARNARD, SEPTEMBER 2).—The following ephemeris for Berlin midnight is in continuation of that given in NATURE for 1888 December 27 (p. 211) :—

1889.	R.A. h. m. s.	Decl.	Log *r*.	Log ⌂.	Brightness.
Feb. 9	23 42 28	4 28·0 S.	0·2598	0·4096	2·6
11	23 41 51	4 18·5			
13	23 41 18	4 8·9	0·2608	0·4196	2·5
15	23 40 47	3 59·3			
17	23 40 19	3 49·7	0·2621	0·4284	2·4
19	23 39 54	3 40·1			
21	23 39 31	3 30·5	0·2637	0·4362	2·3
23	23 39 11	3 20·9			
25	23 38 52	3 11·3 S.	0·2656	0·4429	2·2

The brightness at discovery is taken as unity.

HAYNALD OBSERVATORY (HUNGARY).—The results of the observations of solar prominences at this Observatory during the year 1886 have just been published (Kalocsán, 1888). The observations were made with a telescope of 190 millimetres aperture, and a spectroscope consisting of six flint glass prisms. The chief object was to determine the dimensions of metallic prominences, and their relations to sun-spots. Tables showing all the details of the observations, and the daily and monthly means are given. Prominences less than 20″ in height have been neglected. There are also three plates—the first showing the forms of some of the largest prominences observed, and the second indicating the state of the chromosphere for each day of observation between September 1 and October 31. The third plate, showing the relation of the heights of the prominences to latitude, is particularly interesting. The highest prominences in 1886 occurred in latitudes 18° N. and 37° S., whilst there were secondary maxima in 45° N. and 8° S., and tertiary maxima in 80° N. and 75° S. The secondary maxima do not fall far below the principal ones, but the tertiary maxima are not nearly so well marked.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 FEBRUARY 10-16.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 10

Sun rises, 7h. 24m. ; souths, 12h. 14m. 28·9s. ; sets, 17h. 4m. : right asc. on meridian, 21h. 37·5m. ; decl. 14° 11' S. Sidereal Time at Sunset, 2h. 28m.

Moon (Full on February 15, 22h.) rises, 12h. 7m. ; souths, 20h. 12m. ; sets, 4h. 23m.* : right asc. on meridian, 5h. 36·5m. ; decl. 21° 1' N.

Planet.	Rises.	Souths.	Sets.	Right asc. and declination on meridian.	
	h. m.	h. m.	h. m.	h. m.	° '
Mercury..	7 23	12 45	18 7	22 8·0	8 8 S.
Venus ...	8 41	15 6	21 31	0 29·9	4 14 N.
Mars ...	8 28	14 19	20 10	23 42·0	2 39 S.
Jupiter ...	4 46	8 41	12 36	18 3·5	23 6 S.
Saturn ...	16 18	23 52	7 26*..	9 17·1	17 1 N.
Uranus ...	22 37*...	4 0	9 23	13 21·9	7 56 S.
Neptune..	10 44	18 27	2 10*..	3 50·8	18 25 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Feb.	h.	
15	1	Mercury in inferior conjunction with the Sun.
15	1	Saturn in conjunction with and 1° 5' south of the Moon.

Variable Stars.

Star.	R.A.	Decl.		
	h. m.	° '		h. m.
U Cephei ...	0 52·5 ...	81 17 N.	... Feb. 12,	19 30 *m*
Algol	3 1·0 ...	40 32 N.	... ,, 11,	0 59 *m*
			,, 16,	18 37 *m*
λ Tauri...	3 54·6 ...	12 11 N.	... ,, 13,	19 39 *m*
ζ Geminorum ...	6 57·5 ...	20 44 N.	... ,, 12,	6 0 *M*
R Canis Majoris...	7 14·5 ...	16 11 N.	... ,, 14,	20 7 *m*
		and at intervals of	27	16
R Virginis ...	12 32·9 ...	7 36 N.	... Feb. 11,	*M*
U Coronæ ...	15 13·7 ...	32 3 N.	... ,, 14,	20 34 *m*
Y Cygni ...	20 47·6 ...	34 14 N.	... ,, 11,	5 40 *m*
		and at intervals of	36	0
δ Cephei	22 25·0 ...	57 51 N.	... Feb. 12,	0 0 *m*
R Lacertæ ...	22 38·3 ...	41 47 N.	... ,, 15,	*M*

M signifies maximum ; *m* minimum.

Meteor-Showers.

	R.A.	Decl.		
	°			
From Camelopardalis ...	110 ...	62 N.	...	Slow.
,, Monoceros	120 ...	5 S.	...	Slow.
Near β Ophiuchi	263 ...	2 N.	...	Very swift.

GROWTH OF OUR KNOWLEDGE OF THE NEBULÆ.

OUR present knowledge of those celestial bodies which we term nebulæ may be said to date from a paper by Sir William Herschel on nebulous stars, published in 1791 (Phil. Trans., vol. lxxxi. p. 71). It is perfectly true that we have not here the first recorded observations of nebulæ : several observers before Sir William Herschel, and Sir William Herschel himself, had previously referred to them. All observers previous to Sir William Herschel, among whom we may include Kepler, Tycho Brahé, Halley, and others, were of opinion that the nebulæ were composed of something differing entirely in its essence from stars. There was no question whatever of their being simply clusters of stars considerably removed. Tycho Brahé, in the record of his observations of the new star observed by him in Cassiopeia, suggested that it was in some way generated from an ethereal substance, and to him the Milky Way was composed of the same material. This ethereal substance was liable to dissipation by light and heat, and in this way he accounted for the ultimate disappearance of the star. Kepler shared this opinion, and it may be stated that it was generally accepted at the time that Sir William Herschel began his observations of nebulæ about the year 1780. His first important paper, however, did not deal with these objects : it had reference to the

motion of the sun in space (Phil. Trans., vol. lxxiii., published in 1783). In this memoir he points out the universal sway of gravitation in the celestial spaces ; and the infinite possibilities opened out by such an all-prevailing and pervading cause seem, although he does not state it in terms, to have led him to the conclusion that such ideas as Brahé's and Kepler's were invalid. His first real survey of the nebulæ appears in his paper of 1784 (Phil. Trans., vol. lxxiii.) He began by observing those bodies which had already been recorded in the *Connaissance des Temps* for 1783, and then those further afield ; and it is not a little remarkable that in this first paper he describes almost every distinct form of nebulæ which has been observed from that day to the years about 1846, when Lord Rosse brought a still more powerful instrument than Herschel's largest to bear upon these objects. He noticed that in certain parts of the heavens there was a marked absence of stars, and that this was so invariably followed by the appearance of nebulæ on the confines of the empty region that he records in his memoir that after passing over one of them he was in the habit of giving the word to his assistant to "prepare for nebulæ." This strengthened his view as to the power of gravitation, and as to nebulæ being masses of stars produced by it.

In another paper published in the next year (Phil. Trans., vol. lxxv.) he shows evidently that to him the nebulæ of all orders which he had discovered were simple agglomerations of stars, and he refers to the action of gravity in bringing about such condensations. In the next year (Phil. Trans., vol. lxxvi.) he published the first catalogue of a thousand nebulæ, and gives his first classification, one based upon brightness (p. 466). In 1789, that is three years later (Phil. Trans., vol. lxxix.), he published his second catalogue, and it is clear from the text that he still considered nebulæ to be all distinct star clusters. It required another interval of three years before the possibility of their nature being in any way distinct was brought fairly before his mind. In 1791 (Phil. Trans., vol. lxxxi.) he published his remarkable paper on "Nebulous Stars properly so-called." In this paper it will be seen how convincing was the line of argument which Herschel followed to bring him ultimately to the conclusion that in the bodies which he observed there was either a central body which is not a star, or a star involved in a shining fluid of a nature totally unknown to us (p. 83).

This conclusion seems to have made a profound impression upon Herschel's mind, and we had to wait for ten years before he returned to the subject. He did so in 1801 (Phil. Trans., vol. ci.), in a paper detailing " Astronomical Observations relating to the Construction of the Heavens, arranged for the purpose of a critical examination, the result of which appears to throw some new light upon the organization of the celestial bodies." In this paper he classifies all the different kinds of nebulæ which were then known to him, and specimens of which, as has been before stated, he really seems to have glimpsed in his paper of 1784. He points out that, in the classification which he proceeds to give, the bodies under consideration are treated in such a manner that each shall assist us to understand the nature and construction of the others ; and he endeavours to attain this end by assorting them into as many classes as are required to produce the most gradual affinity between the individuals contained in any one class and those contained in that which precedes and that which follows it (p. 271). He remarks : " This consideration will be a sufficient apology for the great number of assortments into which I have thrown the bodies under consideration."

His classification may be stated as follows :—

1. *Extensive diffused nebulosity.*—Under this title he includes faint nebulosities stretching and branching over various portions of the sky, which he was the first to discover by means of the enormously increased optical power which he brought to bear. He states that "they can only be seen when the air is perfectly clear, and when the observer has been in the dark long enough for the eye to recover from having been in the light" (p. 274). He gives fifty-two of these diffused nebulosities, which he had observed in the nineteen years from 1783 to 1802. He remarks that "extensive diffused nebulosity is very great indeed ; for the amount of it, as given in the tables, is 151·7 square degrees ; but this, it must be remembered, gives us by no means the real limits of it ;" and he finally adds, "it will be evident that the abundance of nebulous matter diffused through such an expansion of the heavens must exceed all imagination."

2. *Nebulosities joined to nebulæ.*—He refers to fourteen

objects in which real nebulæ are distinctly associated with the above diffused nebulosity.

3. *Detached nebulosities.*—He next mentions six cases in which, instead of the extensive diffusion referred to under the first head, the nebulosity is found detached.

4. *Milky nebulæ.*—He here remarks that when detached nebulosities are small we are used to call them nebulæ, and he shows that the nebulosities and the nebulæ, whatever may be their appearance, as well as those expressly called by him "milky," partake of the same general nature.

5. *Milky nebulæ with condensations.*—He refers to the brightest portions of the nebula in Orion as an indication of what he means by condensation ; then to another in which the greatest brightness lies towards the middle ; and then he adds :— "By attending to the circumstances of the size and figures of this nebula we find that we can account for its greater brightness towards the middle in the most simple manner by supposing the nebulous matter of which it is composed to fill an irregular kind of solid space, and that it is either a little deeper in the brightest place, or that the nebulosity is perhaps a little more compressed. It is not necessary for us to determine at present to which of these causes the increase of brightness may be owing ; at all events it cannot be probable that the nebulous matter should have different powers of shining, such as would be required independent of depth or compression " (p. 282).

6. *Nebubæ which are brighter in more than one place.*—He associates the general swelling of the nebulous matter about the places which appear like nuclei with the unequally bright places in the diffused nebulosities, and further on he refers to universal gravitation "as a cause of every condensation, agglomeration, compression, and concentration of nebulous matter."

7. *Double nebulæ with joining nebulosity.*—He points out that "in fifteen objects two nuclei or centres of attraction have been observed, and that if the active principle of condensation carries on its operation a diffusion of their at present united nebulosities must in the end be the consequence " (p. 285).

8. *Double nebulæ not more than 2′ from each other.*—He points out that there are twenty-three of this class.

9. *Double nebulæ at a greater distance than 2′ from each other.* —Of these he gives a hundred examples, pointing out that "there are not more than five or six which differ so much in brightness from one another that we can suppose them to be at any very considerably different distance from us " (p. 288), and he further adds that "equal brightness or faintness runs through them all in general."

10. *Treble, quadruple, and sextuple nebulæ.*—He refers to twenty treble, five quadruple, and one sextuple object of each kind.

11. *Very narrow long nebulæ.*
12. *Extended nebulæ.*
13. *Irregular nebulæ.*
14. *Nebulæ that are of an irregular round figure.*
15. *Round nebulæ.*
16. *Nebulæ that are remarkable for some peculiarity of figure or brightness.*—He ascribes this irregularity as the as yet imperfect concentration of the nebulous mass in which the preponderating matter is not in the centre (p. 300).
17. *Nebulæ that are gradually a little brighter in the middle.*
18. *Nebulæ which are gradually brighter in the middle.*
19. *Nebulæ that are gradually much brighter in the middle.*
20. *Nebulæ that are suddenly much brighter in the middle.*
21. *Round nebulæ increasing gradually in brightness up to a nucleus in the middle.*
22. *Nebulæ that have a nucleus.*
23. *Round nebulæ that show a progression of condensation.*
24. *Round nebulæ that are of an almost uniform light.*
25. *Nebulæ that have a cometic appearance.*
26. *Extended nebulæ that show the progress of condensation.*
27. *Nebulæ that draw progressively towards the period of final condensation.*
28. *Planetary nebulæ.*

In addition, Sir William Herschel in his various papers gives drawings illustrating the classification which has been above referred to (Phil. Trans., vol. ci. Plates 4 and 5, and vol. civ. Plate 11). A more elaborate set of plates illustrating the various gradations of the different forms will be found accompanying Sir John Herschel's catalogue (Phil. Trans., vol. cxxiii., 1833, Plates 9, 10, 11, 12, and 13). In these illustrations will be found some forms of great interest not referred to by the elder Herschel. Long parallel nebulæ, for instance, with a dark

streak separating them, and elliptic and ring nebulæ. With these exceptions, all the illustrations readily fall into Sir William Herschel's classification.

In the valuable paper of Sir John Herschel, to which reference has been made, there is evidence to show that he gives up the idea of nebulous matter distinct from stars advocated by his father. He says : "If the nebula be anything more than a cluster of discrete stars, as we have every reason to believe, at least in the generality of cases, no pressure can be propagated through it" (Phil. Trans., 1833, vol. cxxiii. p. 502). Coming down to the work of Lord Rosse, we find that as early as 1846 he had convinced himself almost completely that no such thing as so-called nebulous fluid existed. In a letter to Nicol ("Architecture of the Heavens," p. 143) under date March 19, referring to the nebula of Orion, he states that he could "plainly see that all about the trapezium is a mass of stars, the rest of the nebula also abounding with stars and exhibiting the characteristics of resolvability strongly marked."

The magnificent observations of the nebulæ made by Lord Rosse will be found in the Philosophical Transactions (R. S.) for the years 1850 and 1861, the latter giving an account of the work done by the 6-foot, and in the Scientific Transactions of the Royal Dublin Society for 1880. In the volume for 1861, p. 702, Lord Rosse seems rather inclined to withdraw the very definite letter which has been previously quoted, and states that, "When the letter R, meaning that the nebula is resolvable, has been used, he does not attach much importance to the expression of opinion it conveys, because the question of resolvability can only be successfully investigated when the air is steady and the speculum is in fine order."

This state of uncertainty, however, did not last long, for in 1864 Dr. Huggins and Dr. Miller demonstrated that the spectrum of several planetary and other nebulæ which they examined, instead of giving spectra like those of the stars, gave one of bright lines, one of the lines being due, as they asserted at the time, to hydrogen ; the other, as it lay very near a line of nitrogen, was supposed by them to represent "a form of matter more elementary than nitrogen, and which our analysis has not yet enabled us to detect" (Phil. Trans., 1864, p. 444). Then they wrote :—"It is obvious that the nebulæ (that they had examined) can no longer be regarded as agglomerations of suns after the order to which our sun and the fixed stars belong. We have in these bodies to do no longer with a special modification only of our own type of suns, but find ourselves in the presence of bodies possessing a distinct and separate plan of structure."

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE forty-second annual general meeting of the Institution of Mechanical Engineers took place at 25 Great George Street, Westminster, by permission of the Council of the Institution of Civil Engineers, on January 30 and 31, and February 1, the President, Mr. Charles Cochrane, in the chair.

The three papers down for reading and discussion were : supplementary paper on the use of petroleum refuse as fuel in locomotive engines, by Mr. Thomas Urquhart, Locomotive Superintendent, Grazi and Tsaritsin Railway, South-East Russia ; on compound locomotives, by Mr. R. Herbert Lapage, of London ; on the latest development of roller flour milling, by Mr. Henry Simon, of Manchester.

The author of the first paper states that his object is to bring before the Institution the more recent results of his experience in the use of petroleum refuse as a locomotive fuel, now being used on an unprecedented scale on the Grazi and Tsaritsin Railway. Since the publication of the original paper in 1884, nothing new in principle has been discovered, and the same appliances have been used, having undergone very slight modifications, dictated by experience and constant observation. The whole of the 143 locomotives under the author's superintendence, as well as various stationary boilers of various types, have been fired with petroleum refuse, to the complete exclusion of all solid fuel, as well as in all the heating furnaces at the Company's Central Works at Boriooglebsk. The petroleum refuse is burnt in the form of a spray, being blown into the furnace against a brick structure, serving the double purpose of a reservoir for the heat, and against which the spray is broken up. Many experiments were made with a variety of forms of

brickwork inside the furnace or fire-box, which are duly de-scribed by the author. The spray-injector is of course illus-trated. On this depends the efficient working of the furnace. The oil is blown into the furnace by means of a steam jet. Experiments have been made on the use of compressed air instead of steam ; and, from what could be observed during a two months' trial, the complication and cost of the extra gear would not be recouped by a sufficient economy in fuel consumption. The effect of petroleum fuel on the boilers, after five years' experience, appears to be less destructive than when firing with anthracite, which is particularly destructive to the fire-boxes and tube-ends. The author states that the petroleum flame produces in reality no more detrimental effect on the fire-box and tubes than a wood flame, owing to the protection afforded to the more important parts by the fire-brick lining ; moreover, petroleum refuse contains no sulphur, which is so prevalent in all coals, and so injurious to the metal of the fire-box and tubes. The eva-porative value of petroleum refuse appears to be very high. With an effective steam pressure of 125 pounds per square inch, the highest evaporative duty of the fuel in the author's locomotives has been 14 pounds of water per pound of fuel, in comparison with the theoretical evaporative value of 17·1 pounds. The actual efficiency of the fuel is therefore nearly 82 per cent., the tables giving an evaporation, under the same conditions, for good English coal, of 12·16 pounds of water.

Mr. Urquhart's paper will be read with great interest by those following his example in using various oils and tar as a fuel for locomotives and stationary boilers. Provided a cheap source of fuel in the form of petroleum refuse or oil can be relied upon, the many reasons for raising steam in this way are obvious, to say nothing of the possibility of the machinery being kept free from all the dirt necessitated by the use of coal on a locomotive.

The object of the paper on compound locomotives, by Mr. R. Herbert Lapage, is to furnish an account of some recent practice in designing and working two-cylinder compound locomotives. The advantages of compounding—that is, expanding the steam in more than one cylinder—is due to the difference of temperature between the boiler steam and the exhaust being distributed over two cylinders, with the important result that there is not so much difference as in the ordinary locomotive between the temperature at the beginning and that at the end of the stroke in each cylinder ; consequently there is less initial condensation and less re-evapor-ation of condensed steam, and a more uniform pressure on the pistons throughout the stroke ; and owing to the more constant and even pressure on the pistons, the turning moments about the driving axle are more uniform, giving less sudden strains to the machinery generally, thereby increasing the life of the machine. The fact that so little attention has until recently been paid to the compounding of locomotives appears to be owing to there having hitherto been considerable complication of parts, in connection both with obtaining a simple device for starting the engine and of equalizing the power developed in the high and low pressure cylinders. These objections have now been thoroughly overcome in what is known as the Worsdell and Von Borries system, in which the two-cylinder compound locomotive has been brought to a high pitch of efficiency. The author of the paper describes a six-wheel-coupled goods engine which was sent out in 1886 to the Entre-Rios Government Rail-way, having been built by Messrs. Dubs and Co., Glasgow. This engine was built on the compound principle, after investi-gating the excellent results obtained by the Worsdell and Von Borries system. The dimensions of the cylinders are—high pressure, 16 inches diameter ; low pressure, 23 inches ; both cylinders having a stroke of 24 inches ; the working pressure being 175 pounds per square inch ; diameter of driving wheels 3 feet 9 inches. The total weight in working order is 37 tons, probably having about 30 tons useful weight for adhesion ; the cut-off of the valves in ordinary running being in the high pressure cylinder 40 per cent., and in the low pressure 50 per cent. Various trial trips were made with this compound on the Caledonian Railway, the work done without doubt showing the power and efficiency of the engine. In the locality where this engine is working coal costs at least £2 a ton ; presuming an ordinary engine runs 30,000 miles a year at 25 pounds of coal per mile, it will have burnt 335 tons, which, at £2 per ton, costs £670. The compound, effecting a saving of about 20 per cent., will accordingly save £134 in a year. It is found that a compound locomotive of less weight can haul as heavy a train at the same speed as an ordinary engine, provided the adhesion is sufficient, with the economy of from 14½ to 20 per cent., and as

the cost of the compound is no greater than such an engine, the 20 per cent. or £134 per year saved is a net saving to the engine. Compound express locomotives working the heaviest service, which run about 3000 miles per month, are found to do some 15 per cent. more mileage between shop repairs than the ordinary engines of the same size and class.

The fact that two important papers should have been read before the Institutions of Civil and Mechanical Engineers re-spectively points to the conclusion that the compound locomotive has out-grown the experimental stage. Mr. Lapage says nothing in his paper about the " Webb " system, and probably this is a sign of the " survival of the fittest." The Worsdell engine re-quires little, if any, alteration in the primary parts of an ordinary engine. The number of working parts is not in-creased, and the strains set up in the engine are more uniform and less intense than in the ordinary engine, less steam is used, and therefore the boiler is not worked so hard—in fact, every-thing in connection with the working of these engines points to less general wear and tear of parts, and therefore longer life to the machine.

The last paper on the list, on the latest development of roller flour milling, by Mr. Henry Simon, deals with the extraordinary revolution which, during the last ten years, has been in progress in the manufacture of flour by the substitution of the roller system for the ancient method of grinding by stones ; and the object of the present paper is to give further information about the subsequent development of roller flour-milling as carried out by the author. The completeness of the revolution that has taken place is exemplified by the fact that practically, in less than ten years, the machinery and methods of corn milling have been radically and entirely altered at the cost of an immense amount of capital. The millstone, dating from prehistoric times, has been almost entirely discarded, and the miller has been constrained to unlearn the old methods, and take up one entirely new, based upon very different principles. The first complete roller-mill, without the use of stones, in England, was built by the author in 1878 for Mr. Arthur McDougall, of Manchester, and in Ireland for Messrs. E. Shackleton and Sons in 1879 ; the first automatic roller flour-mill in England in 1881 for Messrs. F. A. Frost and Sons, Chester. The total number of complete mills, or important reconstructions of old mills, executed by the author since 1878 amounts to considerably more than 200, varying in cost for machinery, exclusive of motive power, buildings, &c., from £1000 to £40,000 for each mill.

As it is nearly impossible to give our readers an adequate description of this class of machinery without diagrams, we do not attempt the task, but recommend Mr. Simon's very interesting paper to the careful perusal of all practical millers.

NOTE ON THE ACTION OF ACIDS UPON ULTRAMARINE.

AT the Birmingham meeting of the British Association in September 1886, I read a short paper "On the Fading of Water-colours." This was published in the *Chemical News*, vol. liv.

Observation and experiments had led me to the conclusion that water-colour drawings in which ultramarine was mixed with reds for the representation of purple and gray tints such as are seen when viewing distant mountains, the shadows of clouds, and other luminous shadows, the colours are liable to suffer from the action of acids such as might be found in the drawing-paper, or in the damp atmosphere of towns where much coal is burnt. The general opinion of artists is one which I believe does not coincide with this view. The same series of experiments had shown that under ordinary circumstances indigo was a colour of great stability compared with many other pigments, and this again was in conflict with the experience of artists. It is not impossible to explain how we have arrived at such different views, and though it would be inconvenient to enter into an ex-planation in full, it may be considered as within the scope of this paper to record the fact that the colours were washed upon the best drawing-paper, dried in a subdued light, and not exposed to the conjoint action of damp and sunlight.

The matter in hand is the question of the stability of ultra-marine in presence of acids. In an old work by M. Constant de Massoul, translated into English in 1812, entitled "A Treatise on the Art of Painting and the Composition of Colours," a short

account of ultramarine is given as follows :—" The basis of this colour is *Lapis Lazuli*. This, added to the long and tedious operation of extracting the Blue, makes this colour very dear. In order to prove the goodness of *Lapis Lazuli*, make it red hot upon a plate of iron ; and then throw it immediately into strong white Vinegar. If it loses its colour, it is of an inferior quality. You may likewise form a judgement by its weight, the real Ultramarine being much heavier than the false."

It is stated that the stone comes from Asia, where it is found on the frontiers of Tartary, China, and also from America. Having drawn my conclusions as to the behaviour of ultramarine with acids, from the preparations sold for this pigment, it seemed desirable that the behaviour of the mineral should be studied by itself, and likewise that of the artificial preparation. This latter, I am aware, is variable ; some of it is more easily decomposed by acids than other samples, the difference being occasioned by the greater amount of silica in the latter.

I applied to Mr. Gregory, of 88 Charlotte Street, Fitzroy Square, for as many different specimens of *lapis lazuli* and minerals resembling it as were at his disposal. They consisted of a specimen from Chili, two from Persia of magnificent colour, three from Siberia, Trans-Baikal, and a specimen of a blue mineral often mistaken for *lapis lazuli* called *glaucolite*. This also occurs in the Trans-Baikal district.

These specimens were chipped, where fragments of a fine blue colour were to be seen, and the pieces were ground in an agate mortar to an impalpable powder.

A specimen of each was placed in the hollow of a white earthenware colour palette, and moistened with sulphurous acid. All the specimens of *lapis lazuli* were attacked, and in nearly every case completely decolorized. Where the blue colour was not quite destroyed, the powder was examined with a powerful lens, and it was seen that blue particles remained which had not been sufficiently finely powdered. Several minute lumps of the colour were noticed to be etched by the acid, showing white spots here and there. Hence the fineness of the powder has much influence on the facility with which the mineral is attacked. This is usual with all mineral substances.

It was next considered of interest to ascertain whether *lapis lazuli* will stand the test applied to it by Constant de Massoul, and therefore some of the powdered mineral was made red-hot and thrown into dilute acetic acid ; after waiting for five minutes, the blue colour was not appreciably diminished, and it is to be presumed that its nature would thus be satisfactorily demonstrated. Under these circumstances, however, the colour is in considerable quantity, and though some of it may be acted on, yet it is not all destroyed, neither is the tint altered. But in the previous experiments, the powder was much finer and in a thin layer, and though there was a slight action immediately, yet it was about an hour before the colour was completely destroyed. The specimens did not all behave exactly in the same way : some were destroyed more readily than others, especially those from Chili and from Persia.

It does not appear, therefore, that my statement concerning the use of ultramarine as a pigment upon drawing-paper requires modification. A wash of bluish-gray, obtained by mixing light red with ultramarine, was handed round at the Birmingham meeting, one-half of which was shown to be of a foxy red tint after treatment with sulphurous acid. This is, of course, beside the question as to whether ultramarine is largely used for gray tints in the form of water-colour by artists.

Touching the mineral glaucolite, its composition, according to the analysis of G. von Rath, quoted in Dana's "Mineralogy," is the following : silica 47·49, alumina 27·57, ferric oxide 1·54, magnesia 0·47, lime 17·16, soda 4·71, potash 0·58, and water 0·48 per cent. It is quite unacted upon by the acids which decompose *lapis lazuli*. It is highly improbable that it has ever been used as a pigment, because in the form of powder its colour is poor.　　　　　　　　　　W. N. HARTLEY.

LONDON ANCIENT AND MODERN, FROM A SANITARY POINT OF VIEW.[1]

DR. POORE began by reminding his hearers that the mere age of London was one of the reasons why it became unwholesome. Roman London was buried deeply amongst rubbish of all kinds, much of which was putrescible, and, therefore, a source of danger in the soil.

[1] Abstract of a Lecture delivered by Dr. G. V. Poore at the Sanitary Institute on Thursday, January 24.

Ancient London was well placed and magnificently supplied with water, for in addition to the Thames there were many streams, such as Westbourne, Tybourne, the Fleet River, Walbrook, and Langbourne, which originally were sources of pure water. All these brooks, however, had become disgracefully fouled, and for very shame had been covered over. One great drawback to the site of London was the proximity of marshy land on every side except the north-west, and formerly from this cause malarial fever and dysentery were great causes of the high death-rate.

In mediæval London, and even down to the eighteenth century, the houses were not so closely packed as they are now. Reference to Aggas's map (time of Elizabeth) would show that there was a great deal of garden ground within the City, and on comparing this map with Newcourt's map (Charles II.) it was evident that just before the Plague and the Fire the crowding of houses had become very much greater than it was in the time of the Tudor monarchs, who discouraged building near or in London.

Parker's map (1720) would also show that after the Fire the houses were not so closely packed as in the days of the Stuarts, for in this map a surprising amount of garden ground is visible within the walls. At this time also Moorfields was not built upon, and remained as a playground and air space as it had done for centuries previously. That mediæval London was very unhealthy, a perfect fever den, there could be no doubt. The Black Death in 1349, and the Sweating Sickness two centuries later, were times of great mortality which struck the popular mind, but it was not till 1593, when bills of mortality were first introduced, that we began to have any certain knowledge of the amount or the kind of disease prevalent. There was reason to think, however, that in the eighteenth century (after the Fire and the Great Plague) the deaths exceeded the births by about 600,000 in the hundred years.

The fatal diseases were mainly fevers—malarial fever, smallpox, typhus, measles, and (latterly) whooping-cough. The causes of the enormous mortality of mediæval London were due—(1) To the marshy undrained soil, fouled with refuse of every kind. (2) The filthy state of the unpaved city, and a perfectly swinish condition of the houses of the lower orders. (3) The ill-nourished and drunken condition of the masses, among whom a taint of scurvy was very common. (4) The condition of superstition and brutality (as evidenced by the punishments and the pastimes) which made any measures of public health impracticable. (5) The management of epidemics was bad, with a total neglect to separate the sick from the sound ; and, finally, the medical faculty were scarcely less ignorant and superstitious than their patients.

Turning to modern London, the lecturer said there had been a great and manifest improvement ; but when we looked at the low figure which is called the London death-rate, several things must be taken into consideration, e.g. (1) The London of the Registrar-General included large districts such as Lewisham, Wandsworth, Fulham, &c., which, in great part, were scarcely urban in character ; and these being occupied largely by well-to-do persons, lowered the average death-rate for the whole city. (2) London being a city in which wealthy people abounded, its death-rate must not, in fairness, be compared to a city packed with undiluted operatives. (3) The mobility of the population was so great that this fact must vitiate our statistics, and it was to be remembered that nothing quickened the departure of an individual from London more than ill-health. (4) The age distribution in London was very abnormal. It was largely recruited by selected adults from the country, and there was a great deficit in the extreme ages among which (the very young and very old) death-rate is always highest. (5) Again, the diminishing birth-rate (that for 1887 was 2·8 below the average of the previous ten years) very greatly diminished the death-rate in a city where 158 children out of every 1000 born die before they are one year old.

It was difficult to believe that Londers were very robust when more than 25 per cent. of them had recourse to the public hospitals in the course of the year.

The cause of the diminished death-rate (which was very considerably reduced after every allowance had been made) was due —(1) To the increase of knowledge, not only among doctors, but amongst the people generally, for we must remember that "self-preservation is the first law of Nature." (2) Vaccination, and the modern plan of treating infectious diseases by the prompt separation of the patients, had done a great deal ; the total absence

of small-pox and typhus were mainly due to these causes. (3) The cheapness of food, clothing, and fuel had, of course, diminished the tendency to disease, and the ease with which fresh fruit and vegetables were to be got had abolished the taint of scurvy which was so fatal to our ancestors. (4) The water-supply had been improved, and the intake of the water companies was now removed to a portion of the river less tainted with sewage than that formerly in use. (5) Although the system of sewage disposal was an undoubted evil, and had given us three or four epidemics of cholera, and was the foster-mother of typhoid, still it was probable that so far the balance for good was in its favour, because it had removed a good deal of filth from dwellings.

The outlook in the future was dashed by three considerations : —(1) Our system of sewerage and water-supply had increased overcrowding by enabling us to build houses of any height without inconvenience to the occupant, and without any curtilage whatever, and since all sanitarians recognized that overcrowding was the greatest of all sanitary evils, it was impossible to shut one's eyes to this danger.

(2) There was an expensive and menacing "loose end" to our sanitation in the shape of 150,000,000 gallons of sewage pouring into the Thames every day. The only proper destination of organic refuse was the soil, and it was not possible to see the end of the gigantic blunder we had committed in throwing it into the water.

(3) The rapid increase of population along the Valley of the Thames where sewage disposal is on the same lines as in London, must make us apprehensive for our water-supply, because the various tricks played with sewage in the shape of precipitations, &c., were not probably of a kind to make the effluent a desirable or a wholesome beverage. If the evil effects of free trade are to be counteracted, it will be by returning the refuse of our towns free of cost to the impoverished agriculturist. "If we go on as we are going," said the lecturer, in conclusion, "and if our brethren in the colonies follow our bad example, as they appear to be doing, it will be a Chinaman rather than a visitor from New Zealand who will sit in contemplation on the ruins of London Bridge."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Among the scientific lectures this term, we may note the following :—

Prof. Clifton, Acoustics and Magnetism ; Mr. Selby, Theory of Electrical Measurements.

Prof. Odling, Four-carbon Compounds ; Mr. Veley, Physical Chemistry ; Mr. Vernon-Harcourt, Quantitative Analysis.

On the Biological side, the Linacre Deputy-Professor, Mr. Hatchett Jackson, lectures on the Morphology of the Invertebrata, Mr. P. C. Mitchell on the Morphology of the Cell, and Mr. Barclay Thompson on the Osteology of the Sauropsida. Prof. Burdon-Sanderson's subject is the Nervous System. Prof. Green is giving two courses of lectures on Geology, and Prof. Gilbert lectures on the Rotation of Crops and the Feeding of Animals.

On the Mathematical Lecture List we find that Prof. Sylvester is treating of Surfaces of the Second Order (illustrated by models), Prof. Price of Hydromechanics, and Prof. Pritchard of the Elements of the Planetary Theory.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for December 1888 contains the following :—Note on a new organ, and on the structure of the hypodermis, in *Periplaneta orientalis*, by Edward A. Minchin (plate xxii.). The new organ consists of two pouch-like invaginations of the cuticle lying close on each side of the middle line, between the fifth and sixth terga of the dorsal surface of the abdomen. They are covered by the fifth tergum ; when exposed they are seen to open by two slit-shaped openings, which open backwards. They are lined by a continuation of the chitinous cuticle, which forms within the pouches numerous stiff, branched, finely-pointed hairs, below which are numerous glandular epithelial cells. As to their function, it is suggested that they are stink glands.—On certain points in the structure of Urochæta, E.P., and of Dichogaster, nov. gen., with further remarks on the nephridia of earthworms, by Frank E. Beddard (plates xxiii. and xxiv.). The important

facts recorded about the anatomical structure of the species of these two genera, and on the nephridia in earthworms, do not admit of being further condensed. *Dichogaster damonis*, nov. gen. et sp., is described from Fiji.—On the development of *Peripatus novæ-zelandiæ*, by Lilian Sheldon (plates xxv. and xxvi.). A further supply of living specimens was obtained in January 1888. Twenty-seven out of forty-nine were females. The uteri of all but nine of these were filled with embryos. The stages of development did not allow of all the gaps left in Miss Sheldon's previous paper being filled up, but this paper is a welcome addition to our knowledge. A useful summary of the author's investigations is appended.—Note on the development of Amphibians, chiefly concerning the central nervous system ; with additional observations on the hypophysis, mouth, and the appendages and skeleton of the head, by Dr. Henry Orr, (plates xxvii. to xxix.).—Studies on the comparative anatomy of Sponges, ii. on the anatomy and histology of *Stelospongus flabelliformis*, Carter ; with notes on its development, by Arthur Dendy (plates xxx. to xxxiii.). This interesting paper may be regarded as the first-fruits of Mr. Dendy's researches into the anatomy and embryology of recent Australian Sponges, and we hope to be long favoured with such. The embryos, "each as large as a small pea," of *S. flabelliformis*, Carter, were found in abundance. Though varying in diameter from about 3 to almost 5 mm., they exhibited nearly the same stage of development. Doubtless we may expect at some future time the whole story of their evolution. The membrane connecting the fringes of the "choanocytes," which have been so clearly demonstrated by Sollas in the Tetractinellida, and the occurrence of which in *Leuconia aspera* has been described by George Bidder, also occurs in this Sponge, and has been called by Mr. Dendy "Sollas's membrane."—On some points in the natural history of Fungia, by J. J. Lister.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 24.—"On the Influence of Carbonic Anhydride and other Gases on the Development of Micro-organisms." By Percy F. Frankland, Ph.D., B.Sc. (Lond.), F.C.S., F.I.C., Assoc. Roy. Sch. of Mines, Professor of Chemistry in University College, Dundee.

Carbonic anhydride, hydrogen, carbonic oxide, and nitrous oxide, were the gases employed in a series of experiments for observing what action was exerted by them on pure cultivations of Koch's comma Spirillum, Finkler's comma Spirillum, and the *Bacillus pyocyaneus*. It was found that hydrogen had the least, and carbonic anhydride the most, prejudicial influence upon these micro-organisms. There is, therefore, no longer any doubt that in the anaërobic culture of organisms hydrogen is by far the most suitable medium for the expulsion of air, whilst carbonic anhydride is not only ill-suited owing to its markedly deleterious action upon many forms of Bacteria, but in many cases is quite unfit for such a purpose.

With carbonic oxide and nitrous oxide it was found that although the development of the *B. pyocyaneus* was checked, yet on removing the cultivations to an *air*-chamber almost the same number appeared as were developed on the original air-control plates. This was not, however, the case with Koch's comma Spirillum and Finkler's comma Spirillum, only a comparatively small number of the organisms surviving the exposure to these gases. Similar experiments made with nitric oxide, sulphuretted hydrogen, and sulphurous anhydride resulted in the complete destruction of the above organisms.

January 31.—"Auto-Infection in Cardiac Disease." By L. C. Wooldridge, M.D., Assistant-Physician, Guy's Hospital.

The author had previously described the fact that the lymph and chyle produce a poisonous influence when injected into the blood. The symptoms so produced have been described by the author as "fibrinogen intoxication." The chief symptoms of this condition already described are intravascular clotting, delay in clotting of the shed blood, great tendency to hæmorrhages, occasionally marked fever. In the present paper the author shows experimentally the following :—

(1) To affect the blood a certain quantity of the fluid of lymph, or the fibrinogen solution, must reach the blood in a given time or no poisoning is produced. A small quantity of the fluid, injected rapidly, will cause instant death. The same quantity, diluted and injected during three or four minutes, instead of suddenly, has no effect at all. The author regards

this as an explanation of the fact that normally the flow of the lymph from the thoracic duct into the blood produces no poisonous effect.

(2) It has long been known that mere mechanical disturbance to the circulation, unless it be of a most extreme character, will not produce dropsy. The ligature of the femoral vein in the dog produces no dropsy. But if previous to the ligature, some of the lymph fluid or fibringen solution be injected into the blood, the most severe œdema of the leg is produced, or this accompanied by hæmorrhage.

(3) In cardiac disease and disturbance of the circulation through the lungs there is no reason to suppose that a sudden increase in the flow of lymph ever takes place. But it is certain that the circulation of the blood in the neighbourhood of the thoracic duct is materially slowed in these conditions. This slowing of the circulation acts in the same way as a more rapid injection of lymph, and hence in cardiac disease the conditions for fibrinogen intoxication—auto-infection from the lymph —prevail.

(4) The dropsy, which is so common a symptom of cardiac disease, is commonly explained as being due to the mechanical disturbance of the circulation. This explanation does not harmonize with experimental observations. The fact that even very slight fibrinogen intoxication produces a pronounced tendency to dropsy renders it extremely probable that the dropsy and other symptoms of cardiac disease depend on fibrinogen intoxication.

Physical Society, January 26.—Prof. Fuller, F.R.S., in the chair.—The thanks of the Society were tendered to Mr. Freeman, for presenting to the library a rare and interesting work, "Réflexions sur la Puissance Motrice du Feu, et sur les Machines propres à développer cette Puissance," par S. Carnot, ancien élève de l'École Polytechnique.—Dr. S. P. Thompson read three notes on polarized light, entitled respectively : "The Structure of Natural Diffraction Gratings of Quartz," "Ahrens's Modification of Delezenne's Polarizer," and "The Use of Two Quarter-Wave Plates in Combination with a Stationary Polarizer." Two microscope slides of iridescent quartz (prepared by the late Mr. Darker), which have recently come into the possession of the author, exhibit remarkable peculiarities. Both act like diffraction gratings, one as if the rulings were about 12,000, and the other about 26,000, to the inch. On examining the specimens by the microscope, it was found that the parts which exhibited the grating effect showed a spindle-like structure, and by micrometer measurements the dimensions of the spindle-shaped bodies were determined to be from 1/1000 to 1/3000 of an inch in diameter, and 1/100 to 1/300 of an inch long. These were much too large to cause the effects noticed, but on closer examination it was found that the bodies were crossed at right angles by fine markings, the distances between which are in close accordance with those deduced from the spectra produced. As a probable cause of the phenomenon, the author mentioned a recent paper by Prof. Judd, "On the Production of a Lamellar Structure in Quartz by Pressure," and suggested the possibility of making diffraction gratings by such means. Ahrens's modification of Delezenne's polarizer consists of a total-reflection prism combined with glass plates and black glass mirror, arranged so that the polarized beam is parallel to the original one. The combination of plates and mirror is adopted so as to give enough light and still keep the polarization sufficiently good. One or two plates laid over the mirror are found to give the best results. The fact that a beam polarized by reflection is not coincident with the original beam, renders it inconvenient, if not impossible to rotate the polarizer, and to overcome this defect, the author has arranged two quarter-wave plates, one of which may be rotated. The first plate circularly polarizes the plane-polarized beam, and the second (or rotating one) re-plane-polarizes it in any desired plane. Objects were shown on the screen to illustrate the degree of perfection attainable by using the new polarizer in combination with the two quarter-wave plates.—A note on a relation between magnetization and speed in a dynamo machine was read by the same author. In a note presented to the Society in June last, it was shown that $\Sigma\rho$. $\Sigma R = 4\pi n CS$; where $\Sigma\rho$, and ΣR are the magnetic and electric resistances respectively, $n =$ speed, and C and S the numbers of armature and field windings. By writing the equation in the form—

$$\frac{4\pi CS}{\Sigma R} = \frac{\Sigma\rho}{n},$$

it is seen that, *when the electric resistance is maintained constant, the magnetic resistance is proportional to speed.*—Prof. Herroun

read selections from a paper on the divergence of electromotive forces from thermo-chemical data. The fact that the electromotive forces of voltaic cells do not always coincide with calculated values has not hitherto received a satisfactory explanation, and this paper describes an experimental research bearing on the question. Several suggested explanations are given. In some cells the anticipated chemical change does not occur, and some metals become coated with oxide or subsalts; others are affected by dissolved gases, and the hydration or solution of the salts formed may supplement or diminish the E.M.F. of a cell, as well as the absorption or evolution of sensible heat. The question of absorption and evolution of heat is the one chiefly dealt with. If such actions do take place, the total heat evolved by passing a definite current through the cell must depend on the direction of the current, and by inclosing the cell in a calorimeter the difference should be detected. The total heat developed by a current C in t seconds is—

$$\frac{C^2 rt \mp eCt}{J} ;$$

where r is the resistance of the cell, and e the divergence of the observed from the calculated E.M.F., the – or + sign depending on the direction of the current. In the case of mercury cells, which are usually said to give about half a volt excess E.M.F., the heat was found to be independent of the direction of the current. The heats of formation of mercury salts were then re-investigated, and the results showed that Julius Thomsen's numbers (the ones usually accepted) were greatly in excess of the true values. This accounts for the difference between the observed E.M.F.'s and those calculated from Thomsen's numbers. A copper, silver, nitrate cell was tested in the calorimeter, and the reversible heat effect agreed closely with that deduced from the "thermo-voltaic constant," or divergence of observed from calculated E.M.F. Other experiments on tin, lead, nickel, iron, and calcium cells are described, and the chief conclusions arrived at are : (1) the primary factor in determing the E.M.F. of a voltaic cell is the relative heat of formation of the anhydrous salts of the two metals employed ; (2) that this E.M.F. may set up chemical changes of a different direction and character from those predicable from the heat of formation of the dissolved salts ; (3) that the E.M.F. set up by (1) may be, and usually is, supplemented by the energy due to the hydration or solution of the solid salts, and may have values which accord with the heat of formation of the dissolved salts. The absorption or evolution of sensible heat depends primarily on the attraction between the salts and water, combined with the heat of solution. Finally, the author states that the E.M.F. of a cell gives a more accurate measurement of chemical affinity than that derived from calorimetric observations.

Chemical Society, January 17.—Mr. W. Crookes, F.R.S., in the chair.—The following papers were read :—A cubical form of bismuthous oxide, by Messrs. M. M. P. Muir and A. Hutchinson. When the puce-coloured precipitate produced by adding an excess of potassium cyanide to a boiling solution of bismuth nitrate in dilute nitric acid is repeatedly treated with boiling concentrated potash solution, a residue is left, consisting of tetrahedral crystals of bismuthous oxide, which have a density of 8·838.—Cupric iodide, and the interaction of iodides with cupric salts, by Mr. D. J. Carnegie. By digesting cuprous iodide with iodine and water in a tightly-closed bottle at 80° for a few minutes, the author has obtained solutions of cupric iodide containing as much as 0·82 gramme per 100 cubic centimetres, but has been unable to obtain cupric iodide in the solid state, either from such solutions or by other means. A well-defined basic periodide, CuI_2, $2CuO$, $4H_2O$, was obtained by digesting copper with barium iodide.—Periodates, part 2, by Mr. C. W. Kimmins. The periodates of lead, iron, copper, nickel, cadmium, and silver were described.—Compounds of arsenious oxide with sulphuric anhydride, by Mr. R. H. Adie. A series of compounds, of the formula As_2O_3 . xSO_3, where $x =$ 1, 2, 4, or 8, can be prepared by the interaction of arsenious oxide and either sulphuric acid or sulphuric anhydride.—A compound of boric acid with sulphuric anhydride, by Mr. R. F. d'Arcy.—Notes of experiments with butter fat, by Messrs. A. W. Blyth and G. H. Robertson. The main result of the experiments is to show that butter fat is composed of about 54·5 per cent. of solid crystalline fats, and about 45·5 per cent. of an oil. The authors consider that butter is mainly made up of compound and not simple triglycerides, and have separated a crystalline glyceride, to which they ascribe the formula $(C_4H_7O_2)$. C_3H_5 $\left\{ \begin{array}{l} C_{18}H_{31}O_2 \\ C_{19}H_{34}O_2 \end{array} \right.$

—Gawalowski's method for the volumetric estimation of sulphuric acid, by Mr. B. North.—Note on the 1 : 3 homo- and the isomeric hetero-α-β-dichloronaphthalenes melting at nearly the same temperature, by Prof. H. E. Armstrong, F.R.S., and Mr. W. P. Wynne. In their last note on the isomeric dichloronaphthalenes (Proc. Chem. Soc., 1888, 104), the authors brought forward evidence proving that the dichloronaphthalene melting at 61°·5, and characterized by yielding a sulphochloride melting at 148°, is the meta- or 1 : 3-derivative, and pointed out that the dichloronaphthalene melting at 64°, and characterized by yielding a sulphochloride melting at 118°, is the hetero-α-β-dichloronaphthalene. Erdmann and Kirchhoff recently effected the synthesis of a heteronuclear α-β-dichloronaphthalene from parachlorobenzaldehyde, which had a melting of 61°·5 (*Annalen*, ccxlvii. 366). The description of the compound was, however, insufficient to determine its identity, so the authors have prepared it by Erdmann and Kirchhoff's method, and find that it forms a sulphochloride melting at 117°, which, on hydrolysis, yields the pure dichloronaphthalene melting at 63°·5. The authors' conclusions have also received additional confirmation by the synthesis of the 1 : 3 dichloronaphthalene from the 1 : 3 dichlorobenzaldehyde (Erdmann, *Ber.* xxi. 3446). The remainder of the note is devoted to a reply to Erdmann, who, among other matters which are dealt with in the note, calls attention to the existence of two dichloronaphthalenes melting at about the same temperature as if it were an original observation, whereas the fact was first brought under notice by one of the authors at the Manchester meeting of the British Association (B.A. Report, 1887, 231).—The constitution of β-naphthol-α-sulphonic acid (Bayer's acid), by Prof. H. E. Armstrong. The author points out that Witt (*Ber.* xxi. 3489) altogether misrepresents his views on the constitution of β-naphthol-α-sulphonic acid, and quotes passages from his Report to the Manchester meeting of the British Association (B.A. Report, 1887, 231), showing that in his opinion Bayer's acid is a heteronucleal compound, a view, moreover, which has recently found experimental confirmation, inasmuch as the amido-acid corresponding in constitution with Bayer's acid has been shown to yield a heteronuclear α-β-dichloronaphthalene (Armstrong and Wynne, Proc. Chem. Soc., 1888, 104).—The sulphonation of naphthalene-β-sulphonic acid, by the same. The so-called new naphthalenedisulphonic acid, for the preparation of which a patent has been taken out by Ewer and Pick, is identical with that obtained by sulphonating potassium naphthalene-β sulphonate with chlorosulphonic acid (Armstrong and Wynne, Proc. Chem. Soc., 1886, 230).

Royal Microscopical Society, January 9.—Dr. C. T. Hudson, President, in the chair.—Mr. T. F. Smith called attention to his further researches on the structure of *Pleurosigma formosum*. He had found not more than three layers, the first consisting of a grating with square meshes, the second had them of diagonal pattern, and the third was composed of alternate rings and squares. He also described *P. angulatum* as giving appearance of a fine grating showing image in each alternate square.—Mr. Crisp exhibited a form of spirit-lamp sent from America, the reservoir of which was facetted instead of globular, so that it could not be upset and might be used in various positions ; also Mawson and Swan's camera arrangement for fixing on the front of an ordinary camera ; also the binocular arrangement of Messrs. Bausch and Lomb, which, although described in the Journal in 1884, had not until the present time been seen in this country ; also another arrangement for rotating a number of objects so as to bring them in succession under the objective of a microscope.—Mr. A. D. Michael gave an interesting *résumé* of his paper on the internal anatomy of *Uropoda krameri*. He finds that, although the anatomy is essentially of the Gamasid type, yet the external resemblance of *Uropoda* to the *Oribatidæ*, which deceived Hermann, is accompanied by many internal similarities, while many organs differ considerably from those of *Uropoda obscura*, lately described by Winkler. He describes a curious organ which he calls the "vestibule," forming the outer chamber of the female genital system, and which it is suggested may serve to remove the thin egg-shell at the moment of deposition, producing ovo-viviparous reproduction. The female genital organs form a ring with two oviducts, the tracheæ are unbranched ; the alimentary canal, excretory system, and male genital system of the œsophageal ganglion are also described. —Dr. F. H. Bowman's paper on the frustule of *Surirella gemma* was read.—Count Abbé F. Castracane's paper on the reproduction and multiplication of Diatoms, was also read.

Academy of Sciences, January 28.—M. Des Cloizeaux, President, in the chair.—Reaction of oxygenated water on chromic acid, by M. Berthelot. The remarkable character of the reactions of oxygenated water has induced the author to undertake further researches on the phenomena which it manifests in the presence of chromic acid. These studies show that the chemical mechanism of the so-called actions in presence is characterized by three fundamental conditions ; (1) the unlimited nature of the decomposition under certain circumstances, here determined, without permanent alteration of the chromic acid; (2) the formation of an intermediate compound forming the "pivot" of the decomposition : (3) the exothermic properties of the oxygenated water and of the total transformation.—True and mixed butylic ethers (continued), by M. E. Reboul. The study of these compounds is here completed with the description of di-isobutylic ether, $[(CH_3)_2CH—CH_2]_2O$; and secondary

$$(CH_3)_2CH—CH_2$$

isobutylic ether,

$$\begin{matrix} CH_3 \\ \\ CH_3—CH_2 \end{matrix} CH \diagup \diagdown \,O.$$
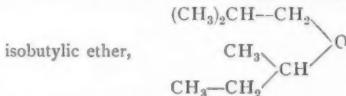
It is further shown that the ethers (7), (8), (9), (10), anticipated by theory, are not produced by the method generally employed. No. 7 (di-secondary ether) has been obtained by Fresnel by a different process.—On M. Marignac's gadolinium, by M. Lecoq de Boisbaudran. The elementary nature of the earth Yα, discovered by M. de Marignac, and since named gadolinium, has been denied by Mr. W. Crookes, who holds that this substance consists of samaria with the greenish blue of yttria, and some of the other yttria bands added to it. M. de Marignac has consequently subjected gadolinium to a fresh analysis with the results here described. M. de Marignac's researches having been interrupted by the state of his health, his papers have been placed in the hands of M. de Boisbaudran, who considers that, although the impurities are not yet entirely eliminated, gadolinium may still be regarded as a new element. He also thinks Mr. Crookes may in this case have exaggerated the difficulties and tedious nature of the preliminary work of fractionation, which, instead of occupying a space of time compared with which "the life of man is all too brief," might perhaps be accomplished in a few weeks. However, he does not deny the extreme difficulty of separating the residuums, which have so far resisted fractionations sufficient to get rid of nearly the whole of Yt and Zα.—On a chromatic circle, an æsthetic recorder and triple decimeter, by M. Charles Henry. These instruments embody a practical application of a theory, the principle of which was communicated to the *Comptes rendus* of January 7, and the chief results of which are here detailed. The chromatic circle has for its object the rational determination of the complements and harmonies of colours ; the two other apparatus are intended to facilitate the æsthetic study and improvement of forms.—On the relation between solubility and the point of fusion, by M. A. Etard. The object of the present note, and of the diagram accompanying it, is to show that solubility increases steadily with the temperature, and that it becomes unlimited at or close to the point of fusion of the salt entering into the solution ; a given quantity of water may then always dissolve a quantity of any salt. It has been supposed that normally the solubility of salt increases up to a certain point and then decreases. But the facts here verified lead to quite a different conclusion.—New solvents of prussic blue, by M. Ch. Er. Guignet. Experimenting with ordinary prussic blue and with Turnbull blue thoroughly purified, M. Guignet has discovered an easy process for preparing ordinary soluble blue and pure prussic blue soluble in water.—On the quantitative analysis of organic nitrogen by Kjeldahl's method, by M. C. Viollette. The author has subjected this new method to certain tests which yield results somewhat different from those recently communicated to the Academy by M. L'Hôte. He finds that, if applied under the conditions here described, it may prove quite as efficient as the processes of M. Dumas and of sodaic lime, although not more expeditious than either.—On the lime present in the ground in combination with other substances, by M. Paul de Mondesir. Nearly all soils, even the most acid, contain a considerable quantity of lime, not as a carbonate, but in combination with the other elements of the earth. It is here shown that this lime may be eliminated at a low temperature by means of diluted acids.— On the precursors of the Canidæ, by M. Marcellin Boule. The

researches which the author is now prosecuting on the Pliocene faunas of the central plateau of France, have afforded an opportunity of studying remains of the canine group older than those of the Quaternary (Pleistocene) epoch, and tending to throw some light on the origin of existing species. During the Middle and Upper Pliocene there existed a considerable number of species, not only closely related to the present Canidæ, but also anticipating the various living forms of dog, fox, jackal, and wolf. These discoveries tend to overthrow the generally accepted opinion that the present domestic varieties of the dog are all merely artificial modifications of living or Quaternary wolf and jackal types.—Papers were contributed by M. Lerch, on the serial development of certain arithmetical functions ; by M. Sauvage, on the regular solutions of a system of linear differential equations ; by M. W. Lœwenthal, on the virulence of the cultivated Bacillus of cholera, and on the action of salol on this virulence ; and by M. C. Pagès, on the locomotion of quadrupeds.

Astronomical Society, January 9.— M. Flammarion, President, in the chair.—Among the communications were the following :—M. de Meissas sent an observation of M. de Boë's second companion to Polaris.—H. R. H. the Prince of Monaco gave an account of the scientific investigations made on board *l'Hirondelle* during the past four years with a view of studying the general physics of our globe.—M. Moussette described an eye-piece for measuring the size of sun-spots and of lunar objects. —M. Mailhat read a paper on a new mercury-bath for artificial horizons, which had been successfully tried at the Paris Observatory.

BERLIN.

Meteorological Society, January 8.—Dr. Vettin, President, in the chair.—Dr. Sprung spoke on some new apparatus for the registration of rainfall and wind.—Dr. Vettin presented a number of curves representing his measurements of the velocity of the wind, by which he confirmed the results of his earlier observations as to the existence of a maximum velocity at midday in the summer, and at midnight in the winter. The measurements were made with Dr. Vettin's feather manometer. On the discussion which ensued, it was pointed out that the records yielded by this anemometer do not confirm the above results.

Physical Society, January 11.—Prof. von Helmholtz, President, in the chair.—The President opened the first meeting of the current year by a memorial address on Clausius, in which he briefly touched upon his most important works and their significance in connection with the whole range of chemistry and physics.—Prof. Kundt gave a short *résumé* of the researches which he had been carrying on of late years on the behaviour of metals to light. He took as his starting-point Kern's discovery that light which is reflected from magnets undergoes a rotation of the plane of polarization, and fully confirmed this as well as all subsequent observations of the English experimenter. In order to avoid any objections which might be raised against the accuracy of the observed phenomenon, he investigated the rotation produced by extremely thin films of metal, whose production was found, after several preliminary experiments, to be most easily attained by pulverizing the kathode *in vacuo*. The light which was transmitted showed signs of rotation, and as a result of a full experimental investigation all metals were found to exert a dextro-rotatory action on light. This law of the positive rotation of the plane of polarized light could be extended to all simple bodies. The thin metallic films further exhibited a doubly-refractive action which led him to determine the refractive index of the metals, after he had succeeded by means of electrolysis in preparing transparent metallic prisms. The speaker described the methods which he employed in these experiments and exhibited the apparatus which he had used. The result of the experiments is already known. The metals possess a varying refractive power, some exhibiting normal, others abnormal, dispersion. The velocity of light in the several metals followed exactly the same serial order as that of their respective conducting powers for electricity and heat. Since it was possible that the deviation of the rays while passing through the metals did not depend upon a true refraction, the speaker had recently examined the behaviour of the refractive indices of the metals at different temperatures. Metals whose refractive index is large showed an increase of the angle of deviation of light as the temperature rises, and thus all doubt as to the fact that he was here dealing with a true refraction was set aside. A further outcome of these experiments was to show that the

velocity of light in metals is dependent on changes of temperature in a way exactly similar to that in which their electrical conductivity is dependent. In order to determine accurately the relationship of the velocity of light to their conductivity, these two values must be measured on one and the same piece of metal. When determining the electrical conductivity in films of metal as thin as those he was using for his optical researches, he found that the greatest difficulty was presented by the measurement of the thickness of the film. In his earlier researches, local thicknesses of 0·11 to 0·14 millionths of a millimetre were measured, values which approximate to the diameter of a molecule. These measurements, the preparation of transparent metallic prisms, and a number of other questions which have become prominent in the course of the above researches, partly carried out by pupils of the speaker, he intends to pursue further.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Life and Correspondence of Abraham Sharp : W. Cudworth (S. Low).— Transactions of the Royal Irish Academy, vol. xxix. Part 3. On Two-nosed Catenaries and their Application to the Design of Segmental Arches: T. Alexander and A. W. Thomson (Williams and Norgate).—A Treatise on Statics, vol. ii. fourth edition, corrected and enlarged : G. M. Minchin (Oxford, Clarendon Press).—Encyklopædie der Naturwissenschaften, Chemie, Zweite Abthg. 49 and 50 Liefg. (Breslau).—Encyklopædie der Naturwissenschaften, Botanik, Erste Abthg. 58 Liefg. (Breslau).—Results of Meteorological Observations made in New South Wales: H. C. Russell (Sydney).— Studies from the Laboratory of Physiological Chemistry, Sheffield Scientific School of Yale University for the Years 1887-88, vol. iii. : edited by R. H. Chittenden (New Haven).—Nautical Monographs, No. 5, the Great Storm off the Atlantic Coast of the United States, March 11-14, 1888 : E. Hayden (Washington).—Annuaire de l'Observatoire 'de Bruxelles: D. Folie (Bruxelles, Hayez).—Butter Making in Denmark : S. Hoare (Norwich).—Le Climat de la Belgique en 1888: A, Lancaster (Bruxelles, Hayez).—Industrial Education in the South: Rev. A. D. Mayo (Washington).—Second Annual Report of the Liverpool Marine Biological Station on Puffin Island : W. A. Herdman (Liverpool).—Insect Life, vol. i. No. 7 (Washington).—Sources of the Nitrogen of Vegetation: Sir J. B. Lawes and Prof. J. H. Gilbert (Trübner).—London Geological Field Class Excursions during the Summer of 1888 (Philip).—Michigan Forestry Commission, First Report (Lansing).— Results of Rain, River, and Evaporation Observations made in New South Wales during 1887: H. C. Russell (Sydney).—Journal of the Society of Telegraph-Engineers and Electricians, vol. xvii. No. 76 (Spon).

CONTENTS. PAGE

era-
ical
tely
e of
s of
, he
ure-
ocal
were
ole-
rent
have
rtly
her.

ED.
w).—
nosed
: T.
e on
nchin
emie,
issen-
teoro-
y).—
ntific
. H.
Storm
ayden
Brux-
Climat
Edu-
nnual
V. A.
ces of
ilbert
mmer
ng).—
South
ety of